POWER

Vol. 36 NEW YORK, AUGUST 27, 1912 No. 9

Available Power Plant Information

When something goes wrong with our "innards" we generally call in the doctor. He looks over the "plant," gets a line on the symptoms, diagnoses the case and prescribes the proper remedy—sometimes.

Professionally, friend Doc. is, in a manner of speaking, a sort of kinsfolk to the operating engineer. But he has this advantage, his "machines" are built pretty closely on the one model. In a dozen power plants there may be twelve differently designed or constructed engines, boilers, pumps, etc. By making a specialty of one line of work—say, erecting boilers—a man may become familiar with most of the types manufactured, but no one operating engineer can know offhand the constructive details of the plant equipment in half-a-dozen medium sized plants.

While many engineers stay in one plant long enough to become familiar with it, unfortunately all do not have that stamina. Perhaps restlessness may lead an engineer into new fields where he does not always increase his store of knowledge. In making these changes, he is "up against it" as everything is usually set up and in operation; he has to step in and keep things going.

While he knows the general operating principles of the engines or boilers he does not know all their construction details, especially their insides. Suppose they begin to show symptoms of ailment. If he has drawings he can study their construction and reason out the probable cause of trouble and apply the remedy. If not he turns "surgeon," taking things apart and hunting for the trouble.

When new machines are installed blueprints, sectional drawings and instruction cards are generally furnished by the manufacturers. These, perhaps, have been turned over to the engineer in charge. He takes care of them for a while, after which they are probably lost or go with him when he leaves.

In some plants the drawings and general instructions are set up in glass-covered frames near the machines. This is a good plan, but the best way is to have all drawings, instructions and notes of changes, alterations, etc., carefully filed in the general office. Then the information is always at hand. Manufacturers are always glad to furnish such matter as will be helpful to the successful operation of their products.

Maps or plans of piping systems, especially underground, should always be available. Then they can be studied so that in case of an accident or an emergency the man in charge will know directly what to do.

Measuring Movement of a Steam Main

By W. N. Stevens

By means of an instrument called a flexometograph, the movement of a point upon a steam main is recorded upon a 10 to 1 scale. The movement of a flange near the end of a 16-in. main 230 ft. long, securely anchored in the middle, was found to be seven-tenths of an inch under working conditions.

In reporting the hearing at Washington by the Navy Department on the "U. S. 1912 Standard" for flanges and flange fittings, POWER referred to experiments by the engineers of the New York Edison Co. to determine the movement of a steam main under working conditions. Through the courtesy of the company the writer is permitted to lay before the readers of POWER a description of the apparatus used and some of the results obtained.

To meet the special requirements of this test, an instrument called a flexometograph was designed. This is shown in front and end views in Fig. 1 and consists of a drum *D* revolved once in 24 hours by a clock *C*. It is carried upon a steel frame work which rests upon some fixed support, as a bracket upon the wall of the building. The flange or other point, the movement of which is to be registered, is attached to the turn buckle *T*, which connects the ends of a wire passing around the hub of the pulley *P* and the idler *p*. The pulley *P* has a diameter ten times that of its hub, and the motion is transmitted by the cord which passes around its periphery and the idlers *F* and *f*. To this cord is attached the slide *S*, which carries the recording pen and has a motion ten times that of the flange, the movement of which is to register.

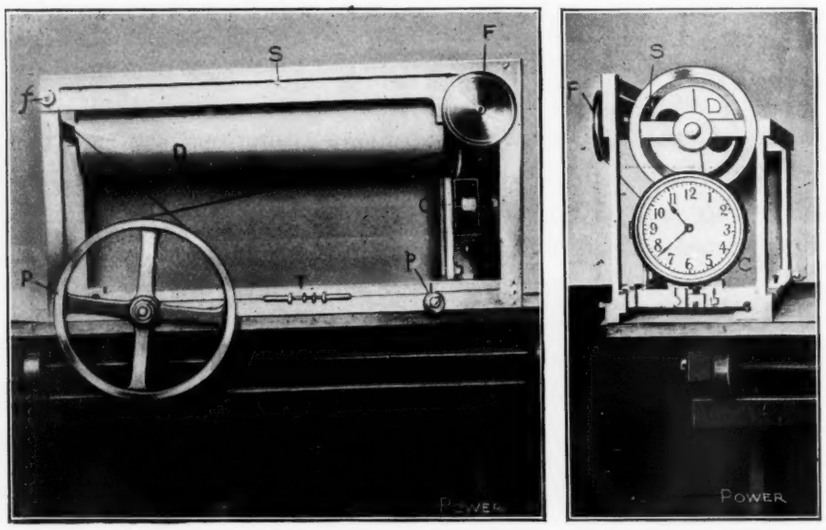


FIG. 1. THE FLEXOMETOGRAPH

The steam header to which this was applied is some 230 ft. long and is shown in elevation in Fig. 2. The location of the flexometograph is indicated at *F*. The pipe is securely anchored at the center and is supported at intervals on rollers to permit of free movement incident to expansion and contraction without undue strain on the flanges and bolts along the line of the header.

Fig. 3 shows the record for Tuesday, Jan. 29, 1907, which is characteristic of those obtained on other days. Upon the original record the heavy horizontal rulings are 1 in. apart, so that each of them indicates a movement of $\frac{1}{10}$ of an inch of the point to which the instrument is attached, while the intermediate rulings indicate hundredths of an inch. The dotted line indicates the variation of temperature in the main at the same time.

As the pipe was under steam pressure throughout the test, the curve shows the movement during the operation of the power house. No record was taken of the movement from a cold pipe to a pipe under steam. The pressure varied from 182 to 200 lb., superheat being used as indicated by the temperature.

It will be seen that the point *S* on the steam main was never at rest. Its movements are continuous throughout the life of the power house. As the outlet flanges of the tees in this main remain parallel to the axis of the main, the leads to the boilers and engines must not only be bent during the movement, but are given a compound bend due to their own expansion as well as that of the main. It is obvious that these leads should not be stiff, but must be as flexible as possible; otherwise the strain on the tees will be enormous. It is most important that no extra-heavy pipe be used in these leads. Extra-heavy pipe defeats the very

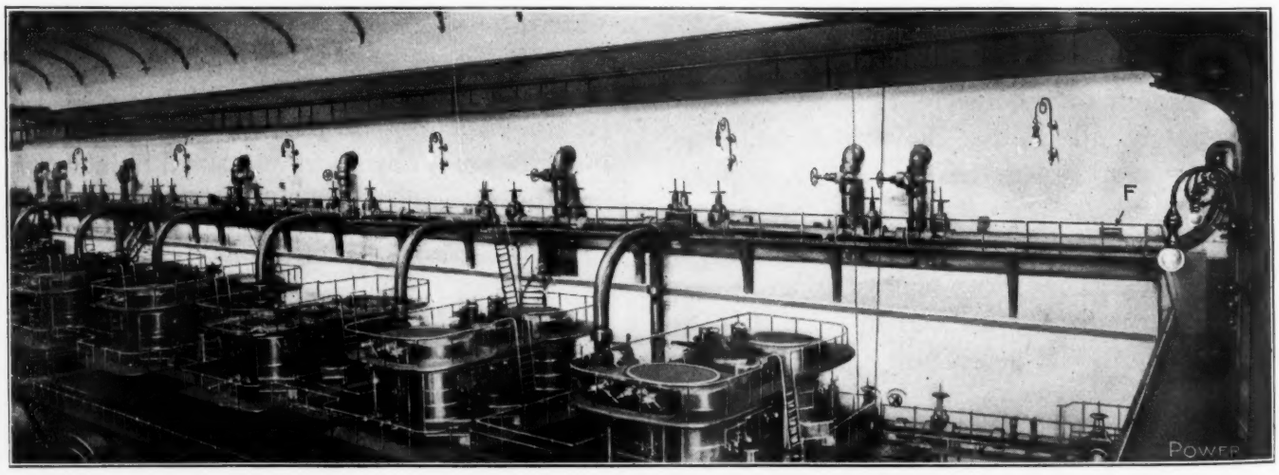


FIG. 2. STEAM HEADER 230 FT. IN LENGTH AT WATERSIDE STATION OF THE NEW YORK EDISON CO. FLEXOMETOGRAPH APPLIED AT F

purpose for which it is employed. It lowers the factor of safety of the tee below the factor of safety of standard weight pipe. This is based on the pipe being made with a Van Stone flange or a welded-on flange and the tee being an extra-heavy cast-steel fitting.

Eight-inch standard weight wrought-steel pipe requires 4000 lb. pressure per sq.in. to burst it. The factor of safety is 20 if the steam pressure is only 200 lb. It is therefore amply strong. With the fittings, however, it is quite different. The never ceasing movement of the pipe

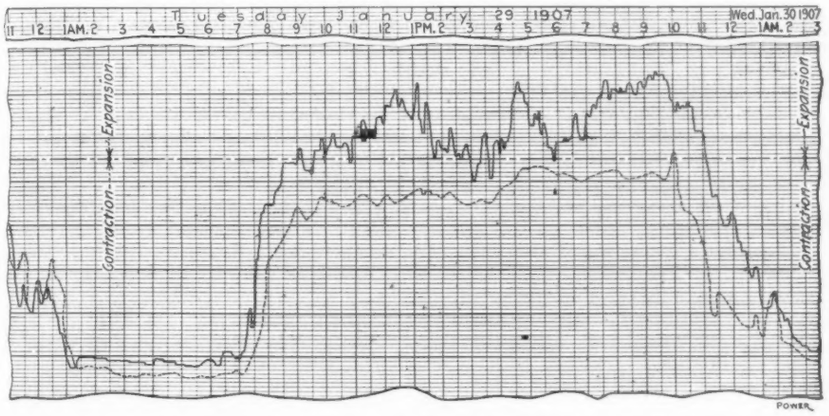


FIG. 3. FLEXOMETOGRAPH RECORD OF PIPE MOVEMENT AND TEMPERATURE VARIATION

subjects them to strains that may be many times those due to the steam pressure, and they are bound to crystalize in time. They must be very heavy and strong and have no abrupt changes in the thickness of metal if they are cast fittings.

Where a high degree of superheat is employed, the movements are correspondingly greater. It is therefore submitted that cast-iron fittings are not good enough for superheated steam. They should be steel. Steel castings can be obtained that are free from shrinkage strains and are sound.

If one could obtain forged steel fittings, they would be still better. The daily cycle which this point *F* follows also shows the importance of so supporting steam piping, that its movements are freely made and that it must be securely anchored at the center of its length.

"How much experience have you had with boilers?" asked the chief engineer of the new applicant.

"Oh, I've been around them quite a lot."

"Of course you know how to handle the injector?"

"Oh, yes."

"What is an injector?"

"Why, the injector, as I understand it, is a little thing that screws on the side of the boiler, with a rubber hose that leads into a barrel."

The Myrawatt, a New Power Unit*

BY H. G. STOTT AND HAYLETT O'NEILL

The object of this communication is to introduce a new unit of power which, if adopted, will afford a basis for comparing all converters of energy, thermal and mechanical, and also will be international in its character, as it is merely a new multiple of the watt.

In American and European practice, there are many empirical units, the use of which is restricted to a distinct territory. A few of the more important are horsepower, boiler horsepower, kilowatt, cheval à vapeur, pferde-kraft or pferdestärke and poncelet. Obviously an engineer in attempting to compare data from a foreign country, is compelled to face a confusion of terms, which usually can be made intelligible only by laborious calculation.

Again, in the United States there are such units as boiler-horsepower and horsepower, which, while similar in sound, have no logical connection; and one has yet to find where the "horse" comes in.

With the rapid development in electrical measuring instruments, and, until recently, a corresponding lack of development in steam-flow measuring instruments, the term kilowatt has become more and more used as the one unit of power output.

The term became a necessity with the growing favor of steam turbines, and all direct-connected units where it is impossible to measure accurately the mechanical and the electrical power separately.

To form a connection between the boiler or producer output, the term "myrawatt"—derived from the Greek "myria," meaning ten thousand, and the term watt—is proposed.

For the purpose of standardization, the British thermal unit, 1/180 of the heat required to raise one pound of water from 32 deg. F. to 212 deg. F. and the equivalent evaporation from and at 212 deg. F. (970.4 B.t.u.) is used (Marks and Davis).

From this, the following equivalents are obtained:

1 foot-pound	= 0.001286	B.t.u.
1 horsepower	= 2,547	B.t.u. per hr.
1 cheval a vapeur	= 2,510	B.t.u. per hr.
1 pferde-kraft	= 2,510	B.t.u. per hr.
1 poncelet	= 3,350	B.t.u. per hr.
1 kilowatt	= 3,415	B.t.u. per hr.
1 boiler horse power	= 33,479	B.t.u. per hr.
1 myrawatt	= 34,150	B.t.u. per hr.

The last two are practically the same, differing by only 2 per cent. The usual practice is to rate water-tube boilers on the basis of one boiler-hosepower per 10 sq.ft. of heating surface.

COMPARISONS IN EFFICIENCIES AND RATES OF OUTPUT WITH VARIOUS TYPES OF ENERGY CONVERTERS, IN TERMS OF THE MYRAWATT

1. Boiler output:

Nominal rating = 600 boiler h.p.

Total draft head. in. water gage	Boiler h.p.	Myrawatts
0.589	817	800
1.170	1174	1151
1.730	1375	1348

2. 5000-kw. engine:

Kw. Output	Lb. steam kw.-hr.	B.t.u. kw.-hr.	Kw. output Mw. input	Per cent thermal efficiency overall
3100	18.2	21,500	1.59	15.9
4977	17.2	20,160	1.70	17
6772	18.5	21,600	1.58	15.8

3. 5500-kw. high pressure turbine:

Kw. Output	Lb. steam Kw-hr.	B.t.u. Kw-hr.	Kw. output Mw. input	Per cent thermal efficiency overall
2283	20.16	23,100	1.48	14.8
5350	16.86	19,160	1.78	17.8
8183	16.39	18,450	1.85	18.5

4. 15,000-kw. engine—low-pressure turbine.

Kw. Output	Lb. steam Kw-hr.	B.t.u. Kw-hr.	Kw. output Mw. input	Per cent thermal efficiency overall
8,347	13.34	15,740	2.17	21.7
11,240	13.19	15,660	2.18	21.8
16,172	15.07	17,500	1.95	19.5

5. 56-in. low head water-turbine:

Brake h.p.	Brake kw.	Kw. output Mw. input	Conversion eff. per cent overall
294	219	7.83	78.3
283	211	8.41	84.1

6. Steam plant efficiency:

Lb. coal per kw-hr.	=	2
B.t.u. per lb. coal	=	14,250
B.t.u. per kw-hr.	=	28,500
Kilowatts per myrawatt input to boilers	=	1.2
Plant efficiency	=	12 per cenf-

7. 2000-h.p. Koerting gas engine direct connected t. blower

Kw. Output	Cu.ft.gas Kw-hr.	B.t.u. Kw-hr.	Kw. output Mw. input	Per cent. thermal efficiency overall
5206	146	14,220	2.4	24

With modern plants, notably those in marine service, operating from two to five times this rating, the ordinary method of determining nominal boiler capacity could be stretched 2 per cent. without materially affecting the present rating; i.e., the boiler might be rated at 34,150 instead of 33,479 B.t.u. per hour for each 10 sq.ft. of heating surface.

The myrawatt as a unit of boiler or producer output, and correspondingly a unit of input to all kinds of dynamical machinery, is fixed in value by the watt,

*Presented at the Boston Convention of the Am. Inst. Elec. Engrs.

and by its very sound gives a clue to its meaning.

To compare efficiencies of direct-connected units and eliminate the various factors of quality of steam, pressure and vacuum, the term, "B.t.u. per kilowatt-hour" has been used. If we use the term myrawatt,

$$\textit{Per cent. overall efficiency} = \frac{10 \times \textit{kilowatts output}}{\textit{myrawatts input}}$$

Also, with the thermal efficiency of the engine known, the heating surface in the boiler room is determined (assuming the 10 sq.ft. rule) thus; 2 kw. per myrawatt input to an engine is equivalent to 20 per cent. thermal efficiency of the engine and the heating surface in the boiler room equals kilowatts engine output × 10/2.

Obtaining an exact figure of the same with the boiler-horsepower unit involves a tedious operation.

The efficiency of internal-combustion-engine-driven units of all cycles, such as Diesel, Brayton, Otto, etc., is determined by rating the heating value of the fuel in myrawatts; thus

$$\textit{Per cent. efficiency} = 10 \times \frac{\textit{kilowatts output}}{\textit{myrawatts input}}$$

With hydraulic machinery, again, rating the water-power input to the wheels in myrawatts, the formula is the same.

Thus, in the term myrawatt lies a simple, logical and universal means of comparing outputs and inputs of all classes of energy converters, the meaning of which will be clear to all engineers wherever a piece of electrical machinery is used.

Jersey City High School Power Plant

By Warren O. Rogers

Several types of main generating units have been installed, water-tube boilers and all necessary auxiliaries for cleaning, ventilating and heating the school building.

For completeness of equipment, the newly installed steam-power plant of the Technical and Industrial High School, Jersey City, N. J., is said to stand second to none installed in similar institutions in the United States.

The new power house is in the hollow square formed by the school building. It is of brick and well lighted and ventilated.

Although numerous types of machines have been installed, they are not to be used for experimental purposes, but the students will be allowed to visit the engine room and obtain practical information regarding steam-plant operation by observation and explanation.

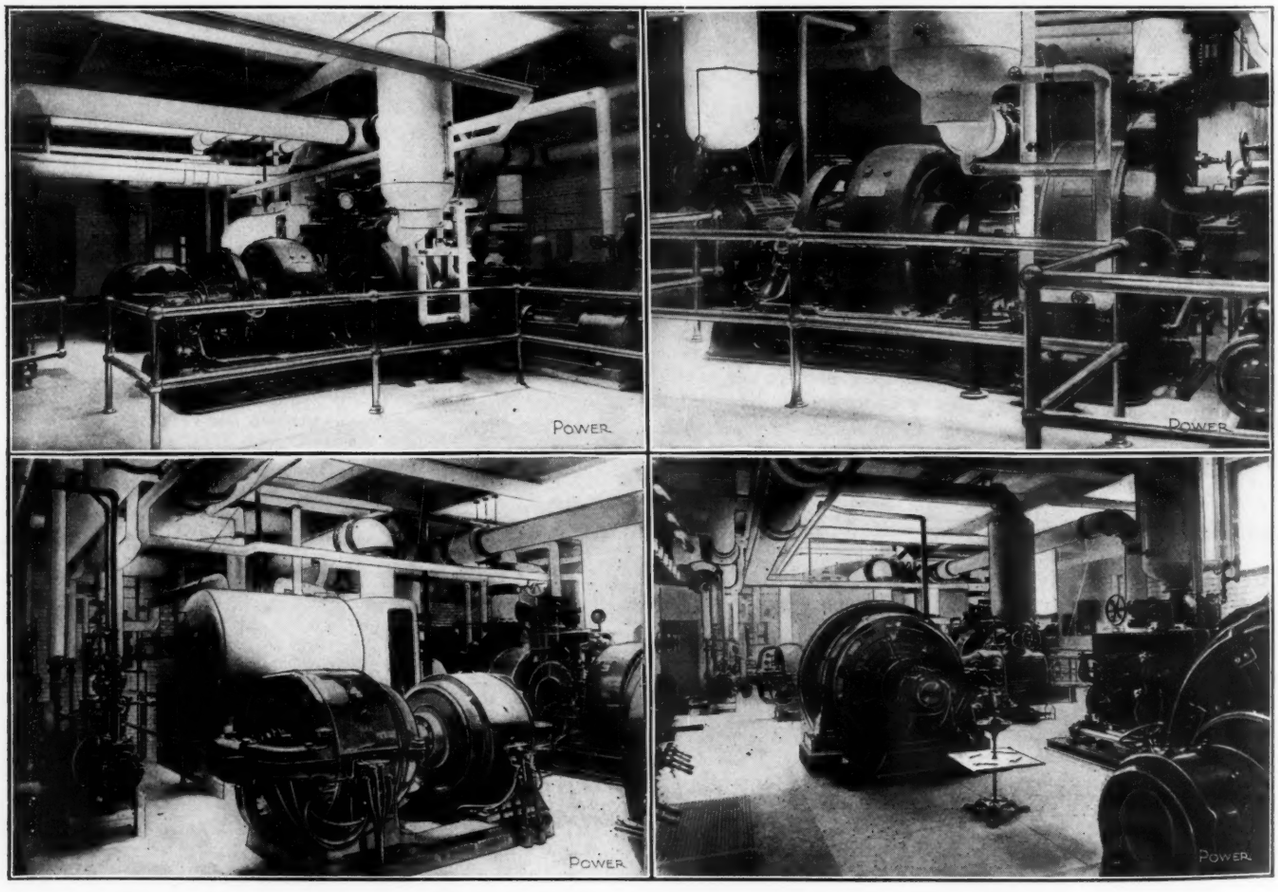


FIG. 1. FOUR VIEWS OF THE ENGINE ROOM

The restricted floor area compelled crowding the machinery somewhat, but even with this handicap the units have been so installed that each can be disassembled for repairing, etc., without undue trouble.

ENGINE ROOM

In the engine room are two steam engines, one steam turbine, a motor-driven generating set, and pumps for boiler feeding, hot-water supply and the heating system. Of the two engines the smaller is a side-crank, medium-speed unit, running 200 r.p.m., and directly coupled to a direct-current generator. This unit at present supplies all the power for lighting, fans, motors, etc., but when the industrial departments have been completed and are in operation, the

large four-valve engine directly connected to a direct-current generator running at 200 r.p.m., will have to be used.

At about the center of the room is a 200-kw. horizontal steam turbine, running noncondensing, connected to a direct-current generator of 800 amp. capacity. The turbine is protected by an automatic safety stop valve on the steam line. The fourth generating unit is a motor-driven set taking current from outside commercial lines at 500 volts. The motor is of 150 hp. capacity, running at 900 r.p.m., and is coupled to a direct-current generator of 400 amp. capacity. This unit is a reserve for use in emergency or to take overload from the other units. The four views shown in Fig. 1 give a good idea of the general arrangement of the engine room, also the pump used for the various purposes. The steam-driven units all have separators, and oiling systems. The load on the three-wire system is balanced by either of two balancing sets, each of 40 kw. capacity.

Boiler Room

Fig. 2 is a view in the boiler room, which contains four 265-hp. water-tube boilers, carrying 135 lb. steam pressure. Each set of two boilers is served by a stack 100 ft. high. The furnaces have shaking and dumping grates. The feed pipes and drips from the water columns are brass.

Buckwheat coal is burned and is hand-fired. It is delivered to a large storage bin under the yard pavement and directly in front of the boilers. The coal wagons are unloaded through a hatchway in the pavement into this room, from which fuel is conveyed to the boiler room in a wheelbarrow. The ashes are removed from the ashpit into barrels hoisted to the ground level by an electric hoist. The blowoff pipes are galvanized iron and discharge into an iron tank, from which the accumulated water is removed by an air ejector to the sewer. The air is furnished by a small air pump, on the wall of the engine room. The draft is controlled by a damper regulator. A forced-draft system is installed but has not been used so far. The draft fan is driven by a 27-hp. turbine running at 1600 r.p.m.

The feed water of the boilers is heated in a closed heater, the supply to which is automatically controlled by a regulator on the feed pump.

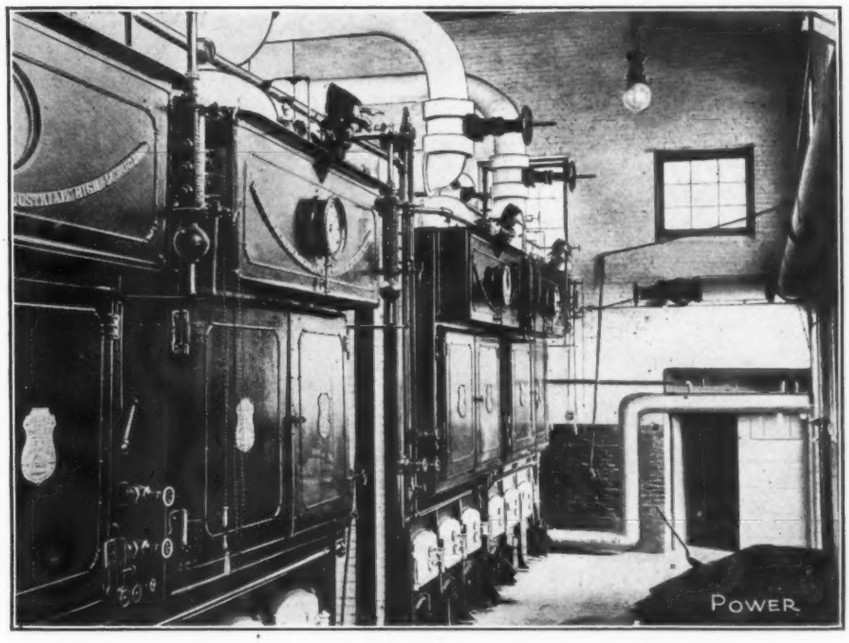


Fig. 2. Partial View of the Boiler Room

EQUIPMENT OF THE JERSEY CITY HIGH SCHOOL POWER PLANT

	Equipment	Make	Use	Kw.	Volts	Amp.	R.p.m.	Size	Pressure lb.	H.p.	
1	Engine	Fleming Harrisburg	Main unit	..	..	..	200	..	130	..	Harrisburg Foundry & Machine Works.
1	Engine	McIntosh-Seymour	Main unit	..	..	..	200	..	130	..	McIntosh-Seymour & Co.
1	Turbine	Curtis	Main unit	200	..	..	1800	..	130	..	General Electric Co.
1	Turbine	Sturtevant	Forced draft fan	..	..	..	1600	..	130	27	B. F. Sturtevant Co.
1	D. C. Generator	General Electric	Main unit	200	250	800	250	..	..	..	General Electric Co.
1	D. C. Generator	General Electric	Main unit	200	250	800	200	..	..	..	General Electric Co.
1	D. C. Generator	General Electric	Main unit	200	250	800	1800	..	..	..	General Electric Co.
4	Water tube boilers	Heine	Main units	..	..	..	..	..	135	265	Heine Safety Boiler Co.
1	Fan	Sturtevant	Forced draft	..	..	..	1600	..	..	..	B. F. Sturtevant Co.
1	Motor	General Electric	Main unit	250	500	250	900	..	..	150	General Electric Co.
1	Generator	General Electric	Main unit	..	250	400	900	..	..	..	General Electric Co.
1	Electric hoist	Gurney	Ash	..	..	..	..	..	..	..	Gurney Electric Co.
1	Heater	Reilly	Feed water	..	..	..	..	31½	..	..	Griscom-Spencer Co.
2	Balancers	General Electric	Distributing lines	14	125	112	1425	..	..	..	General Electric Co.
2	Stacks	Custodis	Smoke	..	..	..	..	100 ft.	..	..	Alphonse Custodis Chimney Construction Co.
4	Water columns	Reliance	On boilers	..	..	..	..	..	..	..	Reliance Gauge Column Co.
1	Air pump	Westinghouse	Sump ejector	..	..	..	..	..	..	..	Westinghouse Air Brake Co.
	Valves	Crane	Main pipes	..	..	..	..	..	..	..	Crane Co.
	Piping	Wrought iron	Steam and water	..	..	..	..	..	..	..	Evans, Almiral & Co.
1	Scale	Fairbanks	Coal	..	..	..	..	..	..	..	Fairbanks Co.
1	Safety stop	Automatic	Turbine	..	..	..	..	..	..	..	Schulte & Koerting.
8	Lubricators	Detroit	Engines and pumps	..	..	..	..	..	..	..	Detroit Lubricator Co.
1	Lubricator	Richardson-Phenix	Engine	..	..	..	..	..	..	..	Richardson-Phenix Co.
2	Air compressors	American	Heating system	..	..	..	..	8x8x8	130	..	American Air Compressor Works.
2	Pumps	Worthington	House service	..	..	..	..	7½x6x10	130	..	Henry R. Worthington
2	Pumps	Simplex	Heating system	..	..	..	..	..	130	..	Union Steam Pump Co.
2	Pumps	Outside packed	Boiler feeder	..	..	..	..	10x6x10	130	..	Henry R. Worthington.
1	Filter	Blackburn & Smith	Water supply	..	..	..	..	..	..	..	James Begg & Co.
4	Regulators	Standard	Pumps	..	..	..	..	..	..	..	H. Mueller.
1	Vacuum cleaner	Richmond	House	..	..	..	..	..	..	..	McCrum-Howell Co.
1	Switchboard	General Electric		..	..	..	..	..	..	..	General Electric Co.
12	Traps	Anderson	Drips and returns	..	..	..	..	..	..	..	The V. D. Anderson Co.
2	Washers	Standard	Air washing	..	..	..	..	No. 4	..	..	Standard Regulator Co.
2	Centrifugal pumps		Air washing water	..	..	..	..	2½	..	..	Platt Iron Works.
2	Motors	Ft. Wayne	Circulating pumps	..	250	2.8	..	..	..	..	Ft. Wayne Electric Co.
4	Fans	Sturtevant	Air circulating	..	..	..	1800	..	..	..	B. F. Sturtevant Co.
7	Fans	Sturtevant	Air circulating	..	..	..	..	7 ft.	..	..	B. F. Sturtevant Co.
4	Motors	Direct current	Air fans	..	250	77	..	7 ft.	..	20	General Electric Co.
4	Motors	Direct current	Air fans	..	250	..	185	..	..	15	General Electric Co.

Pumps

Two outside-packed pot-valve pumps deliver water, after filtering, to the boilers. The exhaust from the engines and pumps passes through a grease extractor. There are also two duplex service pumps and two simplex pumps used on the vacuum system when it is operated. The heating system has thermostatic control, the air supply to which is furnished by two simplex air compressors. All drips from the building are piped to traps discharging into a return tank, and are pumped through a filter to the heater and on to the boilers. The vacuum pumps discharge water from the heating system into a tank near the ceiling, from which it flows by gravity into a second tank, to be pumped to the boilers as feed water.

The school is ventilated by four 7-ft. fans, driven by 20-hp. motors, and seven 7-ft. exhaust fans in the attic, driven by 15-hp. motors.

The current generated by the main units is controlled by switches on a blue-marble switchboard, at one end of the engine room, illustrated in Fig. 3.

The piping in the engine room is suspended from the ceiling by rods and cross hangers, and in some instances tee irons are inserted in the concrete ceilings and beams, carrying I-beams at right angles from which the hangers are suspended.

There are 170 motors in all throughout the various departments averaging 3 hp. each, and 4200 incadescent lamps and 30 arc lights.

Although there are no radical departures in power-plant installation, the completeness of the plant shows that those in authority are alive to the need of providing suitable equipment from which the students taking the industrial course can learn something of uptodate practical operation.

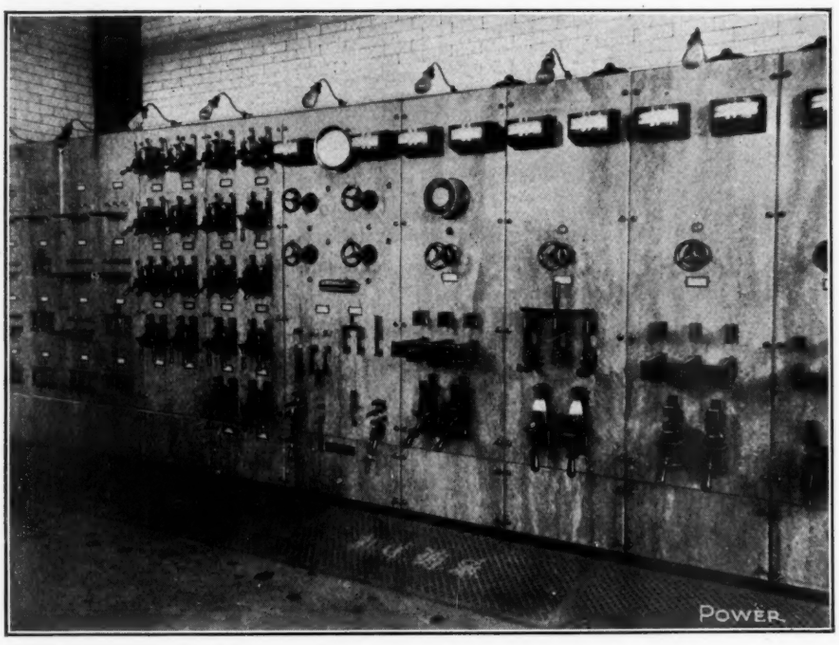


Fig. 3. Switchboard

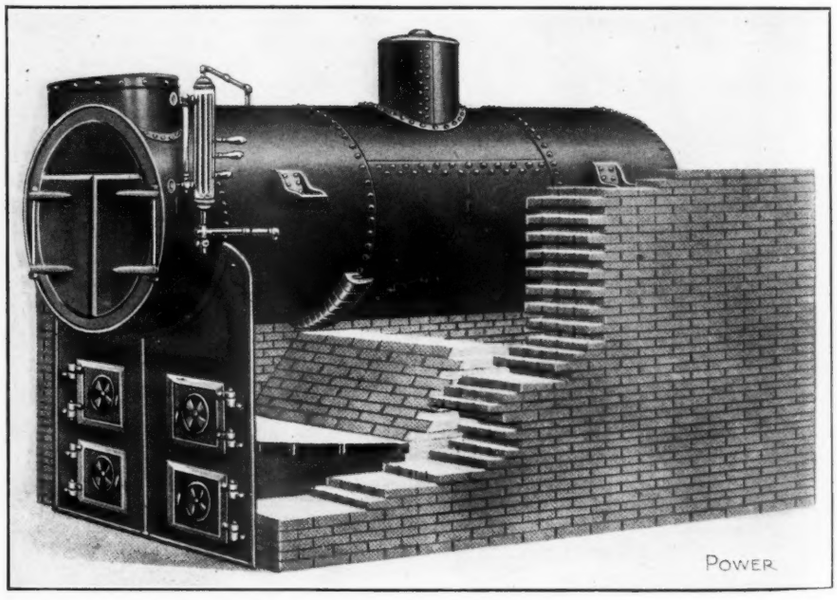
Girth Seam Protector

Horizontal return-tubular boilers are more or less susceptible to trouble from cracks at the girth seam over the fire. One authority estimates that as high as 50 per cent. of the boilers in use develop girth-seam cracks sooner or later. In many cases, such cracks are harmless and if the boiler can be kept tight little attention need be paid to them. However, there is always danger that a crack will extend beyond the rivets and become serious.

The cracks are due to the concentration of heat at the seam where the courses overlap making a double thickness of metal. The distance from the outside to the inside at this point is too great for the water to keep the edge of the outer course cool and hence when the fire-door is opened the inrush of cold air causes extreme contraction and expansion strains and the frequent cracks.

To protect the girth seam by shielding it from the direct impingement of the hot gases and flames or the drafts of cold air, the J. J. Gage Boiler Girth Seam Protector Co., 802 Conover Building, Dayton, Ohio, has placed on the market the device shown attached to a boiler in the accompanying illustration. A piece of ⅝x2-in. bar steel is rolled to conform with the circumference of the shell and is fastened to it by four stud bolts. On this bar are hung a number of special tile of hard refractory clay which fit tightly against the boiler shell as shown. These tile fully cover the seam and also prevent any part of the steel bar or the bolts from coming in contact with the flame.

The protector may easily be attached to any boiler without disturbing the setting.



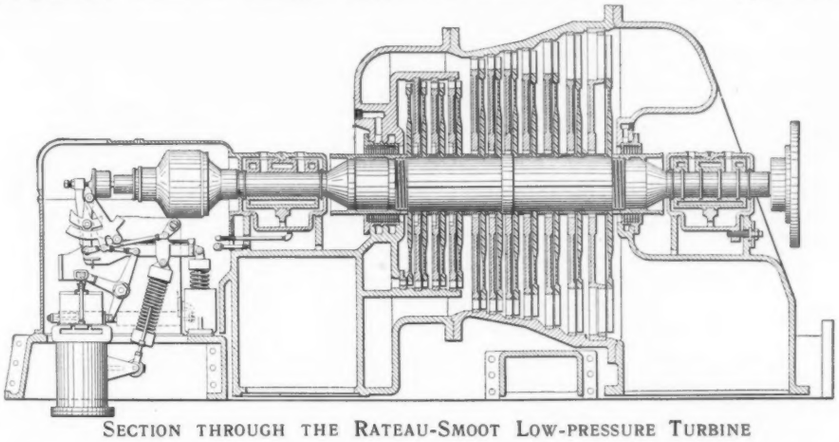
The J. J. Gage Boiler Girth Seam Protector

The latest thing in engineering-society journalism is a periodical published in two languages. The last two issues of the two-monthly *Journal* of the Society of Hungarian Engineers and Architects of America have each contained two leading articles, one printed in Hungarian and one in English. The English article in each case deals with engineering developments in Hungary, while the articles in the Hungarian language describe engineering work in America. This plan might well be adopted by like societies.

Rateau-Smoot Low Pressure Turbine

The Illinois Steel Co. recently installed a low-pressure turbine at its South Works, South Chicago, to utilize the exhaust steam of several reversing engines. The exhaust steam is directed into Rateau steam regenerators so designed that the intermittent flux of exhaust steam is transformed into a steady flow, taking care of full load on the steam turbine not only during the mill cycle, but when the mill cycle is interrupted for periods not exceeding two minutes. The steam turbines are mixed-flow machines of the Rateau-Smoot type.

A cross-section of the turbine is shown herewith. It has an entirely independent high-pressure section. High-pressure steam passes through the high-pressure wheels and, after expanding, enters the low-pressure section. When working on live steam the turbine is a complete high-pressure machine. The low-pressure steam is admitted direct to the low-pressure wheels from around the high-pressure section of the turbine; thus the highest possible economy is attained when working on either high- or low-pressure steam.



SECTION THROUGH THE RATEAU-SMOOT LOW-PRESSURE TURBINE

The governor is so designed that the pressure of the low-pressure steam controls the flow of high-pressure steam, and no live steam is admitted to the turbine before the low-pressure steam has become deficient, or when it has reached atmospheric pressure, in this instance. This occurs when the steam regenerators have been delivering steam during a shutdown of the mill engines for more than two minutes, and during this period the turbine has been carrying full load.

The turbine has a capacity of 3000 kw. when using low-pressure steam exclusively, and when using high-pressure steam can carry a continuous load of 4000 kw.

Only one turbine is in operation, the second turbine being under construction, and will be ready to operate in about 30 days. The bearings are ring-oiled with water-cooled bushings. This is said to be the largest turbine in the world having this form of lubrication and bearing cooling.

The stuffing boxes are built up of a number of consecutive rings of carbon blocks separated from each other by diaphragms and having springs to hold the carbons in contact with the shaft. No adjustment is necessary during the life of the box.

The governor is direct acting. The flyballs and spring against which they act are mounted within a steel shell fixed on the high-pressure end of the turbine shaft. The motion of the flyballs is transmitted by links to the high- and low-pressure throttle valves. The governor is powerful and controls the throttling valves with a high degree of regulation.

When first put into service the turbine regulation was adjusted for a 3 per cent. variation in speed when changing from no load to full load. When placed in parallel with other machines it was observed that this turbine took all of the load when it increased and dropped most of its load when the load decreased, because the other machines with which it was running in parallel were not so closely regulated, and it was necessary to readjust the governor to give a 6 per cent. difference between no load and full-load speed before it would carry its proper share of the load on the entire system.

The governing mechanism is so arranged that the action of the flyballs is to hold the valves open; therefore, the breakage or disconnection of any of the links between the flyballs and valves results in the valve closing automatically by its own weight, which, in the case of the high-pressure valve, is assisted by a closing spring.

The governor is equipped with a releasing trigger, which can be operated by hand or by the overspeed device and acts to disconnect the valves from the flyballs and the governor, permitting the valves to close whenever it is desired to shut down the turbine.

A single hand-operated lever restores both high- and low-pressure valves into proper connection with the governor and also replaces the tripping device. The governor can be tripped and restored to action within two or three seconds, and when the turbine is running loaded the safety trip can be actuated by hand and the valves put back in commission without appreciably disturbing the load carried by the machine, due to the heavy flywheel effect of the turbine and alternator, and also to the extreme rapidity with which a man can operate the governor.

The mixed-flow part of the governor comprises a piston actuated by the low-pressure steam, which rises and falls with the pressure in the low-pressure steam main. When the low-pressure steam has a higher pressure (in this case some 20 lb.), the piston takes its proper position and causes the flyball governor to actuate the low-pressure valve for its full travel while holding the high-pressure valve in a closed position. As the quantity of low-pressure steam decreases, the piston which it actuates descends, giving a greatly increased opening to the high-pressure valve and decreasing the opening to the low-pressure valve until it reaches its lower limit, under which conditions the low-pressure valve is always in a closed position and the high-pressure valve is actuated by the flyballs for its maximum displacement.

An intermittent position of the control piston gives a simultaneous opening to both high and low-pressure valves, thus causing the turbine to run on both sources of steam supply.

By this arrangement the turbine tends to run exclusively on low-pressure steam, when its pressure is above that of the atmosphere, but when the pressure falls to atmospheric the turbine takes less exhaust steam and more high-pressure steam, the governor being a regulator of the low-pressure steam supply.

A feature of this governor is that the load carried by the turbine does not change appreciably when the turbine goes from high- to low-pressure steam, because the change in the source of steam for driving the turbine is accomplished without any change in speed and, therefore, without any shifting in the position of the flyball governor. When the turbine is carrying half load its flyball governor assumes an intermediate position, which is exactly the same whether the turbine is driven with high- or low-pressure steam, or a mixture of both.

The governor effects this change by means of the low-pressure steam and not by the speed of the flyball governor, which, however, is always in direct control of both high- and low-pressure valves and has absolute speed control of the turbine regardless of which kind of steam it is operating upon and also regardless of the performance of the selective device which determines whether the turbine shall run on high- or low-pressure steam.

Shaft Governors

By Hubert E. Collins and Edwin F. Williams

Several shaft governors are described, and the manner in which the governor controls the valve movement is gone into in detail.

Several tables are given which show the various positions of the valve under different conditions.

The shaft governor is especially adapted for engines of comparatively high rotative speed, and the closeness of regulation in such engines is often remarkable. It is possible for the governor to hold the speed practically constant through all ranges of load and even with sudden variations of load.

A number of American engines are designed for moderately high rotative speeds, using Corliss, piston or flat valves in which the admission valves are driven direct from a shaft governor; the exhaust valves are independent and separately driven from a fixed eccentric. On such engines the steam valve both opens and closes the admission, the governor shifting the steam eccentric so as to change its angular advance and throw, keeping the lead nearly constant, thus varying the cutoff. The valve-gears of nearly all these engines are so constructed as to modify the plain eccentric movement of the eccentric rod by certain angular movements of the rocker-arm which accelerate the valve movement during the admission period.

This is done to give wider steam-port opening at any given point of cutoff, avoiding the necessity of abnormally long ports and large clearances where a limited travel of valve is constructively essential.

High-speed American engines have one valve for both steam and exhaust. The governor is on the crankshaft and controls the position of the eccentric, shifting it to alter its angular advance and throw, keeping the lead nearly constant. The range of cutoff is from zero to approximately 72 per cent. of the stroke. Incidentally the opening and closing of the exhaust varies with the varying cutoffs, only in a lesser degree. The same governor is applicable to all valve systems where the admission and cutoff are effected by one valve, whether the exhaust is dependent, as in the single-valve type, or independent as in the four-valve type.

Various forms of shaft governors are used with the single-valve control accomplishing practically the same eccentric movement only in different ways. Fig. 1 shows sectional and side elevations of a governor mounted on the end of a shaft, and driving the valve from an eccentric pin.

With the governor weight *O* in the position shown, the latest cutoff will occur, and at the position *P* no steam will be admitted. Between these positions intermediate cutoffs will be obtained. The arm to which the eccentric pin *E* is attached is pivoted on one of the governor casting arms at *A*, and at the other end is connected with the opposite end of the weight arm at *D* by the link *CD*. As the weight moves from its inner position *O* to its outer position *P*, the end of the eccentric arm moves from *C* to *X*, carrying the eccentric pin *E* from *E* to *F*. This is the governing movement.

The governor springs hold the weight at *O* until the engine is up to normal speed when the centrifugal force of the weight will equal the pull of the springs. An increase of speed will cause the weights to move outward until the two forces just balance, and if sufficient will set the weight against the outer stop *S*, closing the valve and shutting steam off entirely.

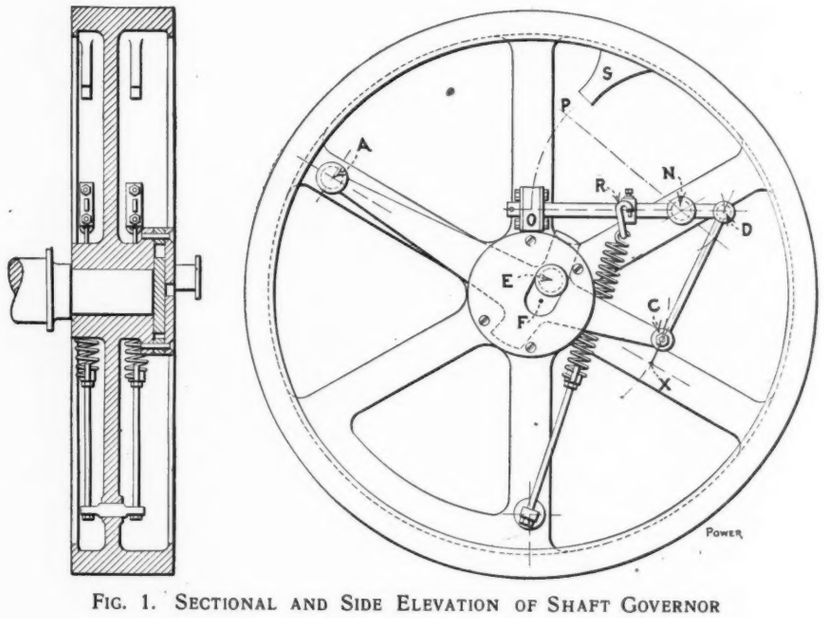


FIG. 1. SECTIONAL AND SIDE ELEVATION OF SHAFT GOVERNOR

In all direct-driven governors, the valve travel being equal to the governor eccentric-rod leg's lateral movement, the distance from *A* to *E* is equal to the distance from *A* to the center of the shaft, plus the steam lap of the valve, minus about $\frac{1}{32}$ in. to cover the port entirely when the eccentric is in its position of least throw. The valve travel with the weight at the inner position is commonly four times the steam lap and its travel with the weight at the outer position is invariably equal to, or slightly less than twice the lap.

In Fig. 2, the outer circle represents the eccentric center when given its greatest throw (the weight being at its inner position), and the inner circle the path of the eccentric center when given sufficient throw to give the valve a travel equal to twice the steam lap. If this were the shortest throw given at the governor, no steam would be admitted. The eccentric center would be located at *D* when the crankpin is at *K* and the governor weight would be at the outer stop. With the engine standing on dead center and the governor weight moved backward and forward between the inner and outer limiting stops, the eccentric would pass back and forth along the line from *C* to *D*. This line is called the even lead line. In practice it is not followed for the reason that it does not admit of lead. The controlling or governing movement is commonly made along the line *EJ* either straight or slightly curved. The shaded portions of the diagram representing no admission, it will be seen that there is positive lead at *E* and negative lead at *J*, the controlling movement crossing the even lead line at *F*. When the weights are at their outer stops the eccentric center is at *F*, a point within the no-admission zone, where no steam can be admitted at any position of the piston.

In Fig. 3, the outer circle represents the path of the crankpin, the central circle the path of the eccentric center at greatest throw, and the inner circle the path of the eccentric at least throw. The line *AP* is the even lead line.

The piston valve is shown in the position it would have were the eccentric anywhere along the even lead line. Whether the governor weights were in or out, the valve would be at the point of opening when the piston is at the beginning of the stroke—the crank being on the dead center.

Evidently, were the eccentric center permanently located at *A* and the crank rotated in the direction of the arrow, the valve would immediately open and stay

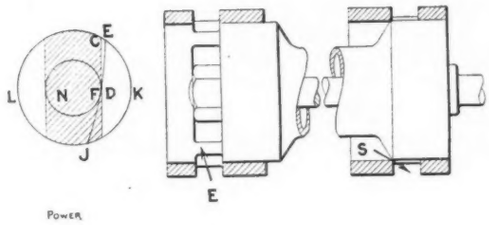


FIG. 2. REPRESENTING ECCENTRIC CENTER AT GREATEST THROW

When a single valve for both steam and exhaust is under governor control, the exhaust opening and closing points vary with the cutoff, being early when the cutoff is early, and late when the cutoff is late.

In Fig. 4, the outer circle represents the path of the crankpin, the next circle the path of the eccentric center at full throw, the next its path when the governor has reduced the throw sufficiently to occasion a 30 per cent. steam admis-

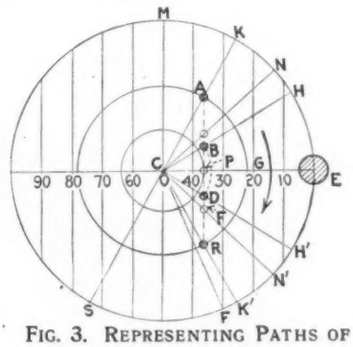


FIG. 3. REPRESENTING PATHS OF CRANK PIN AND GREATEST AND LEAST ECCENTRIC THROW

so until the point *RA* was reached. During this period of admission, the crankpin would have traveled from *E* to *S*, an angular distance equal to that from *A* to *R*. Disregarding for the present the angularity of the connecting-rod, the point of cutoff corresponding to the crank position *S* is 75 per cent. of the piston stroke.

With the governor weight at the inner stop therefore, the valve admits steam 75 per cent. of the stroke. With the weight at the outer stop, the eccentric center being at *P*, there will be no admission period. With the weights at an intermediate position, the eccentric center being at *B*, the admission period would be from *B* to *D*, the corresponding crank angle being *ECF* and the cutoff being at 30 per cent. of the piston stroke.

The lap being fixed and the travel of the valve variable, the lineal port opening and the admission period may be expressed in terms of the lap. For example, with the eccentric center at *A*, the lineal opening *PG* equals the lap *CP* and the travel of the valve is four times the lap *CP*. With the eccentric at *B* the lineal opening is 0.187 of the lap, and the valve travel is 2.374 times the lap.

In Table I is given the valve travel and the lineal port opening referred to the steam lap uncorrected for the connecting-rod angularity.

TABLE 1

Per cent. of admission	Travel of valve referred to lap	Lineal opening referred to lap
10	2.08	0.0416
20	2.208	0.104
30	2.374	0.187
40	2.54	0.29
50	2.79	0.395
60	3.123	0.565
70	3.625	0.81
75	4.00	1.00

sion, and the inner circle no steam admission. The shaded part of the diagram indicates no admission, its breadth just equaling the steam lap. When the eccentric has full throw, its center will be at the opening point *F*, when the crankpin is at *A* on a dead center, and the admission period will be equal to the arc *AB* terminating at *B*, which is 75 per cent. of the stroke, the angular length of the arc being 120 deg. The exhaust side of the valve having no lap, steam is released at *H*, 30 deg. ahead of the opening point for steam admission, and the crankpin being on center, and piston

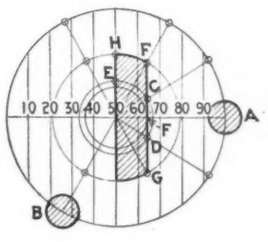


FIG. 4. PATH OF CRANK AND ECCENTRIC

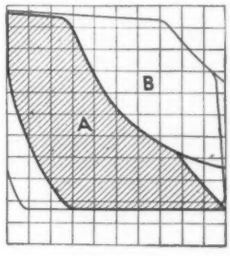


FIG. 5. VALVE ACTION AT TWO POINTS OF CUTOFF

at the beginning of the stroke, the point of exhaust closure and opening takes place at the 150 deg. angle, which corresponds to 86 per cent. of the stroke.

Assume the governor to have shifted the eccentric center to *C*. The angular advance will be increased to 56.5 deg., the steam admission will have been shortened to 30 per cent. of the stroke and the exhaust action will have been transferred to *E*, which is 56.5 deg. ahead of *C* and the exhaust will open at 77.5 per cent. of the stroke and close at the same per cent. of the return stroke.

With the eccentric center shifted to its extreme inner position at *F*, no steam will be admitted and the exhaust opening and closing point will be advanced to the 90-deg. crank angle, which is 50 per cent. of the stroke.

The following table gives approximate points of exhaust opening and closure and crank angles corresponding to varying points of cutoff:

TABLE 2

Period of steam admission, per cent.	Part of stroke completed when exhaust opens, per cent.	Part of stroke to be completed (compression period), per cent.	Crank angle at point of cutoff, deg.
5	62.5	37.5	27.0
10	67.0	33.0	37.5
15	68.5	31.5	45.5
20	73.0	27.0	55.0
25	75.0	25.0	60.0
30	77.5	22.5	66.5
35	80.0	20.0	72.5
40	82.5	17.5	78.5
45	83.5	16.5	84.0
50	85.0	15.0	90.0
55	86.8	13.2	96.0
60	88.0	12.0	101.5
65	90.0	10.0	107.5
70	91.5	8.5	113.5
75	93.0	7.0	120.0

Fig. 5 shows the valve action at two different points of cutoff, namely, 30 per cent. and 75 per cent. The shaded area gives the distribution of pressures for 30 per cent. admission. The exhaust opens at 77 or 78 per cent. of the stroke and closes at the corresponding position on the return stroke, giving a compression period of approximately 22.5 per cent. of the stroke. From the unshaded diagram *B*, showing a three-quarter cutoff, it will be seen that the exhaust opens and closes much later, so that very little compression occurs. The governor, therefore, controls by compression as well as by admission; adding to or taking from the area of the indicator diagram in both ways simultaneously.

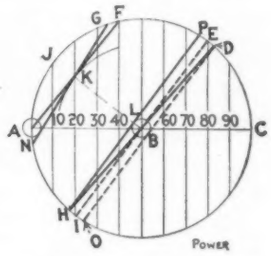


FIG. 6. DIAGRAM TO DETERMINE THE EXHAUST CLOSING AND OPENING PERIOD

Lead can be obtained in this valve system only by moving the governor around the shaft in the direction of rotation until the desired lead is obtained with the governor weights in, eccentric at full throw and the crankpin on the dead cen-

ter. When secured to the shaft in a position to give lead at the full throw of the valve, the governor will diminish that lead until it becomes zero on the shorter cutoffs and negative at the shortest travel of the valve. Hence the valve should be given excessive lead at full throw, say 5 per cent. of the valve travel.

The effect of lead is to advance the position of the eccentric relative to the crank for all cutoffs. This hastens the exhaust and limits the steam admission.

Lead affords a greater lineal valve opening for a given cutoff, the approximate increase being equal to one-half the lead.

Assume a valve having 5-in. travel to have sufficient lap to cut off at 30 per cent. of the stroke without lead. The lap and point of opening may be found from Table 1. If the valve is given 5 per cent. lead (¼ in.) the lap may be reduced ⅛ in. and that amount will be added to the lineal opening of the port at full travel.

Generally there is no lap, either positive or negative, on the exhaust side of the valve. When the per cent. of cylinder clearance is large, however, positive exhaust lap is beneficial as it gives more compression and, incidentally, a later release. With small cylinder clearances, a little negative exhaust lap is advisable. In all cylinders having, say, 8 per cent. clearance, make the exhaust lap zero. When the clearance is from 10 to 14 per cent., make the exhaust positive equal 5 per cent. of the full valve travel. If the clearance does not exceed 5 per cent., the exhaust lap should be negative, approximately 2½ per cent.

A simple method of determining the points of exhaust opening, closing, etc., originated by Prof. John E. Sweet, is shown in Fig. 6.

Draw the outer circle equal in diameter to the travel of the valve. Then draw a circle whose radius *KL* equals the steam lap. Then, if there is no steam lead, draw from *A* the straight line *AF* tangent to the steam-lap circle, intersecting the travel circle at *F*. This is the point of cutoff without lead. By dividing the diameter *AC* into ten equal spaces and erecting perpendiculars at each division terminating in the travel circle it is easy to determine the per cent. of the stroke corresponding to any arc of crank movement beginning at zero.

It will be seen that the cutoff at *K* is at 40 per cent. of the stroke. Draw the straight line *HD* parallel to *AF*, passing through the center at *L* and terminating in the circumference of the outer circle at *D* and *H*. The former is the point of exhaust opening, approximately 82 per cent. of the stroke, and the latter the point of exhaust closure, approximately 18 per cent. of the stroke, when there is no lap on the exhaust side of the valve.

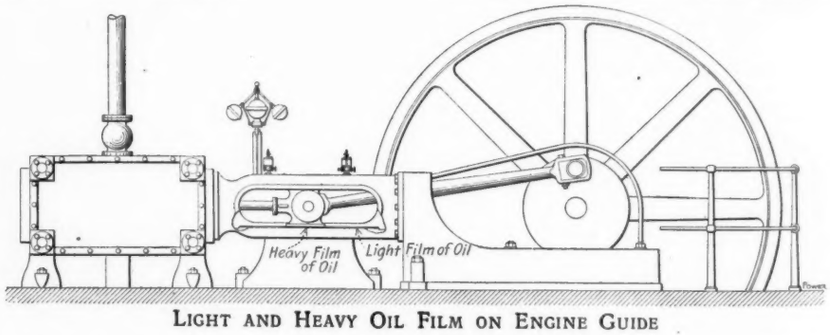
If lead is given the valve, draw the small circle at *A* with its radius equal to the lap, and draw the straight line *NG* tangent to this and the lap circle terminating in the travel circle at *G*. This is the point of cutoff with lead, approximately 35 per cent. of the stroke. Draw the straight line *IE* parallel to *NG*, passing through the center *L* and terminating at *E* and *I*. The point *E* is the exhaust opening and the point *I* the exhaust closure with steam lap, but with no exhaust lap.

If there is exhaust lap, draw the small circle at *L* with a radius equal to the exhaust lap and the straight line *OD* tangent to the circle at *L* and parallel to the line *NG* when there is steam lead, or parallel to the line *AF* if there is no lead. The exhaust will open at *D* and close at *O*. If the exhaust lap is negative draw the straight line *HP* tangent to the exhaust-lap circle *L* on the other side and parallel to the line *AF* if there is no steam lead, or parallel to the line *NG* if there is steam lead. The terminals *H* and *P* will represent the exhaust closure and opening, respectively. It will be seen that positive exhaust lap hastens the closing and retards the opening, while negative exhaust lap does just the reverse.

This method is strictly accurate throughout, covers the whole ground, and is the most simple and direct of any known to the writers.

Crosshead Pressure on Guide

Engineers have for years discussed the advantages and disadvantages of running an engine over and under. An engine will operate more quietly when running over than when running under, because it is not necessary to adjust the crosshead shoe so closely and there is no drop to the crosshead from the upper to the lower guide.



LIGHT AND HEAVY OIL FILM ON ENGINE GUIDE

When an engine is running under the pressure is between the bottom crosshead shoe and the lower guide at both ends of the stroke. But the center of the upper guide sustains the crosshead thrust at midstroke.

In the accompanying sketch the lightly shaded portion on the guides at the ends represents the thin oil film as it will show on the guide when an engine is running under. The dark shading represents a heavy deposit of oil, showing that the crosshead shoe is forced up against the upper guide during the central portion of the stroke and that it drops to the lower guide at each end of the stroke.

Moisture in Exhaust Steam

For many reasons it is highly desirable to ascertain the quality of the exhaust steam of engines and turbines, but, owing to the fact that the moisture is not evenly distributed throughout the cross-section of the exhaust discharge, this is usually a very difficult problem.

One company reports its experience in investigating this subject to the Prime Movers Committee of the National Electric Light Association as follows:

"To make a practical determination of the percentage of moisture present in the exhaust of the 46 × 94 low-pressure cylinder of a vertical cross-compound engine, operating on 25 in. of vacuum, with steam at 175 lb. pressure and with 45 deg. of superheat, openings were made into the exhaust chamber and a nozzle inserted, which was piped through a Carpenter separating calorimeter and a small condenser and connected to the dry vacuum pump which served the engine.

"The relative amounts of water collected in a given time by the calorimeter and by the condenser were, of course, an indication of the percentage of moisture carried by the exhaust steam. This same apparatus was later connected to the exhaust chamber of a steam turbine operating on 27½ in. vacuum. The averages obtained in each of these two tests indicated that the exhaust of the reciprocating engine carried 14 per cent. of moisture and the exhaust of the turbine carried 16 per cent. of moisture, although determinations made at different parts of the exhaust pipe of the engine gave results varying from 6 to 28 per cent., and the determinations made in different parts of the turbine base gave results varying from 6 to 18 per cent."

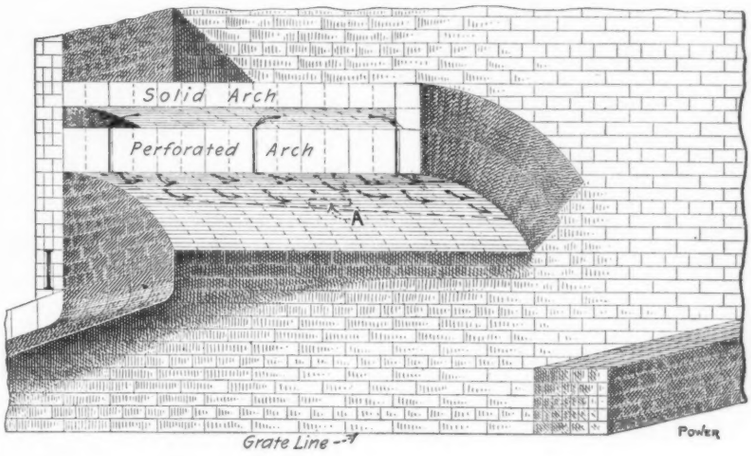
Probably the most carefully conducted investigation of this subject is that reported by Messrs. Stott and Pigott in a paper read before the American Society of Mechanical Engineers in December, 1910, and published in the *Transactions for* 1911, Vol. XXXII, page 69.

It is reported that the Government Bureau of Standards is about to make an investigation of this general subject.

Ventilated Furnace Arch

The accompanying figure shows the Carr ventilated furnace arch, designed and patented by E. E. Carr, Monadnock Block, Chicago, Ill. The object of the design is to prevent the arch from becoming overheated, thereby prolonging its life and reducing the cost of maintenance.

The structure really consists of two separate arches, an upper solid and a lower perforated arch. As the main or combustion arch is being built, series of openings are formed in the joints between the brick through which the draft



VENTILATED FURNACE ARCH

causes a proper supply of air to circulate. These openings lead into the air chamber between the main arch and the single-ring arch built over it, the space between the two being sealed off at the rear. Air from the outside is admitted at any convenient point in the boiler setting, as at *A*.

In traveling over the main arch and through its openings, the air conducts the excess heat away from it, thus tending to prevent the brick from being so softened by the heat as to cause the arch to become unstable and fall. This makes it possible to build the arch very flat and thereby secure the added advantage due to the more even distribution of the flame and gases across the boiler tubes.

An Economical Trapping System

At the saltpeter works of Battelle & Renwich, Jersey City, N. J., a novel steam trap system has just been started up, which not only takes care of the condensation from all the apparatus throughout the mill and returns it to the boilers, but is so arranged that the waste vapor from the vents of the traps is condensed and returned with the regular condensation.

The mill apparatus consists of 19 special kettles for boiling. Each kettle is equipped with what is known as a pit coil; that is, the drip from the coil instead of passing through the bottom of the kettle is carried up over the edge, so that the water of condensation is raised 6 ft. before it is discharged. The system also includes a dry-room and drying machines. The approximate steam capacity required for the boiling alone is about 600 hp. The boiling point of some of the liquids in the kettles is as high as 270 deg., so that live steam is required.

On account of the fact that the coils are submerged in the kettle and the condensation has to be lifted some 6 ft. over their sides it is necessary to keep up a continuous flow of steam to carry this water along. To effect this the special No. 20 Lytton trap with which each kettle is equipped is bled in the steam space, the escaping steam being collected in a common main and utilized in the dry room. The traps discharge their water into return mains of which two are used running back through the factory to a receiving tank in the boiler room. The temperature of this returned water varies between 260 and 282 deg. The condensation from the dry room is also returned to the boilers so that no steam nor vapor is allowed to escape.

On the boilers are located two 4-in. return traps and one 1½-in. return trap, which take care of the return water from the factory at the temperatures mentioned and return it automatically to the boilers. The condensation from the live-steam mains is also trapped and collected in a separate return which discharges into the receiver in the boiler room.

By the installation of this system the saving in coal alone amounts to 2.5 tons per day, while the boiling capacity of quite a number of the kettles is increased from 15 to 25 per cent. It has not only made a saving in coal and increased the capacity of the kettles, but it is feeding the boilers with about 90 per cent. of pure water which prevents the formation of scale and makes an additional saving in the amount of water that would have to be purchased from the city. The system was devised by D. J. Lewis, Jr., sales manager and trap expert of the Lytton Manufacturing Corporation.

Uehling CO_2 Meter Improvements

The Uehling Instrument Co., Passaic, N. J., has recently introduced several improvements in its CO_2 machines and waste meters. One of these is a consequence of experimental work completed about a year ago, and since then, instead of caustic solutions, dry absorbers have been installed on practically every CO_2 machine out in service, and have been furnished with all new equipments.

The dry-absorber cartons are cylindrical, about 3 in. in diameter and 1½ ft. long, encased in wax pressboard, so that they are easily handled. The absorbent, a flakey substance called natron, is packed in layers within the carton, which is placed in the cylindrical chamber. To renew the absorbent it is only necessary to remove a few wing nuts, withdraw the used carton and insert the new one.

The new type *M* recorder is for service in connection with CO_2 meters or the pneumatic pyrometer (operating on a similar principal), or the waste meter which measures both CO_2 and the temperature. It is a light-pressure or vacuum recorder for vacuums, or pressures, or both, from 0 to 60 in. of water column. When this is supplied for recording CO_2, the chart is calibrated from 0 to 20 per cent. CO_2, and when supplied for recording temperature, it is calibrated up to 1000 deg., or for other ranges as desired. This recorder supercedes a somewhat larger gage, but is operated on the same U-tube principle, being filled with a special oil and involving no levers, pins, springs or similar devices.

In connection with the waste meters, the CO_2 and temperature may be recorded on separate type *M* instruments properly calibrated, or a new instrument just developed may be used and the temperature and CO_2 recorded on the same chart. This instrument, the type *DM*, is similar to the type *M*, but carries two pens and gives a chart with a double reading.

An engineering congress will be held in connection with the exposition at San Francisco in 1915 to commemorate the opening of the Panama Canal. At a meeting of representatives of the four national engineering societies, it was agreed to recommend to these organizations and to the Society of Naval Architects and Marine Engineers that they, together with members on the Pacific Coast, underwrite the expenses of the congress.

Electrical Department

Conducted to be of service to the men in charge of electrical equipment in the power house

Synchronous Booster Rotary Converters with Compound Interpoles

Since the ratio of the direct to the alternating-current voltage in a synchronous rotary converter is practically constant under all conditions of load, to change the voltage of the direct current delivered, necessitates changing that of the applied alternating current. This is undesirable as most converters are operated on constant potential alternating-current circuits.

Several methods are in use for obtaining the desired direct-current voltage regulation to compensate for line drop, but all have their limitations. The synchronous-booster type of rotary converter, however, is now being strongly recommended for this purpose as having many advantages over the other methods. This type of machine, as now built consists of an ordinary rotary converter, having the armature of an alternating-current generator (booster) with the same number of poles, mounted on the same shaft next to the collector rings. By controlling the booster field, the voltage can be made to boost or to lower the alternating-current potential to the converter, thus varying the direct-current voltage in the same ratio.

In the smaller machines the field of the booster is supported on brackets from the main frame of the converter, but the larger machines have the booster frame mounted on the bedplate similar to the main field structure.

Interpoles as applied to rotary converters fulfill the same functions as their more familiar application to direct-current generators and motors; that is, they compensate the armature reaction tending to distort the field, and the neutral plane of the latter remains fixed at all loads. Consequently it is unnecessary to shift the brushes with a change in load. Their application to rotary converters is not new, but a combination of compound-wound interpoles with a synchronous booster converter, represents one of the latest products of the Westinghouse Electric & Manufacturing Co.

Fig. 1 shows the usual wiring connections for a synchronous-booster type rotary converter with compound interpole windings. The booster field is permanently connected in series with the shunt windings on the interpoles. The shunt interpole winding is connected to buck the series interpole winding when the booster is raising the alternating-current voltage, and assists the series winding when the booster is lowering the voltage. This may be explained as follows: As already mentioned the series interpole winding moves the neutral back so that the axis of commutation is at right angles to the axis of the field. This condition is satisfactory as long as there is no current in the booster field, but upon exciting this, the neutral position is shifted backward. The shunt interpole winding, being in series with the booster field, and connected so as to oppose the series winding on the interpoles when the booster is raising the voltage, bucks the interpole flux and effectually prevents the neutral brush position from shifting. With normal field

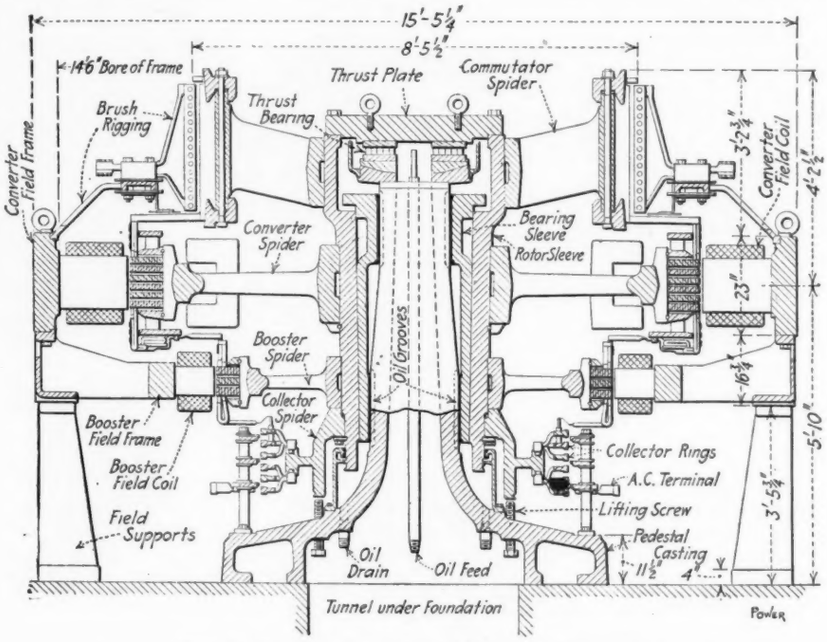


FIG. 2. SECTION THROUGH 3000-KW. CONVERTER

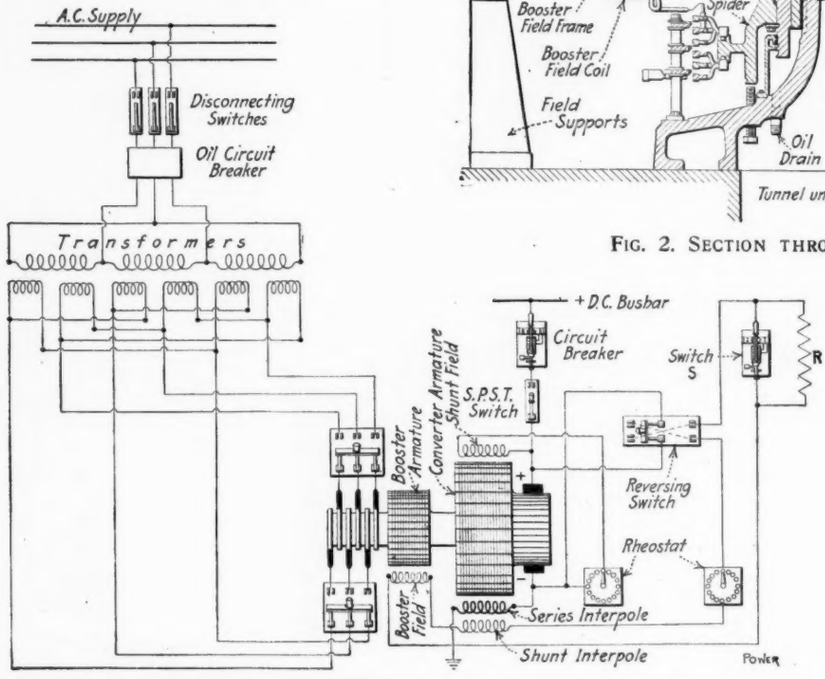


FIG. 1. TYPICAL DIAGRAM OF CONNECTIONS FOR SYNCHRONOUS BOOSTER ROTARY CONVERTER WITH COMPOUND INTERPOLES

on the booster, it is capable of raising the direct-current voltage about 15 per cent., and with full booster field, the interpole flux is practically zero at full load, because the ampere turns of the series interpole coils are approximately equal to those of the shunt interpole coils.

To lower the direct-current potential, the polarity of the booster field and the shunt interpole coils is reversed. In this case, the booster tends to move the neutral position ahead (since the booster itself is now acting as a motor); consequently, a stronger interpole flux, obtained by both interpole windings acting together, is required to hold the neutral where it belongs.

The switch *S* in Fig. 1 is so attached to the circuit-breaker that it closes when the circuit-breaker is closed, and the resistance *R* is thereby short-circuited. Upon opening the circuit-breaker, the resistance is introduced into the circuit of the booster field and the shunt interpole windings by the opening of the switch *S*. It is necessary to introduce this resistance, which is slightly greater than the combined resistance of the booster field and the shunt interpole windings, in the shunt interpole circuit to prevent the neutral from shifting when the circuit-breaker is tripped under load. The series interpole winding is, of course, cut out of

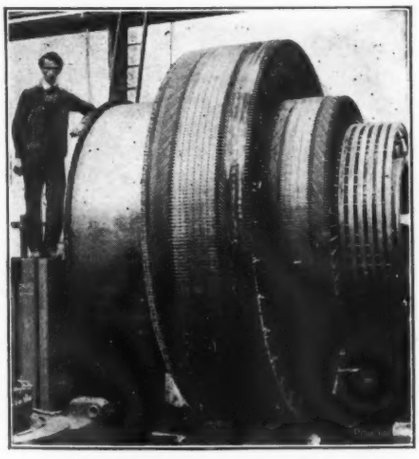


FIG. 3. ARMATURE FOR CONVERTER AND BOOSTER

circuit by the opening of the breaker and the shunt interpole winding in that case, having nothing to buck or help it, depending on whether the booster is raising or lowering the voltage, would move the neutral position either forward or backward, and cause sparking at the brushes if it were not for this resistance.

Rotary converters of this type operate very successfully and commutate at 50 per cent. overload without sparking.

Two 3000-kw., vertical, synchronous-booster type, commutating-pole, rotary converters have just been built and tested by the Westinghouse Electric & Manufacturing Co, for the New York Edison Co., to be installed respectively in its Clinton and its Crosby St. substations. These machines are of unusual interest because they are the largest vertical rotary converters ever constructed and because they are the only vertical converters built involving the synchronous-booster and commutating-pole features.

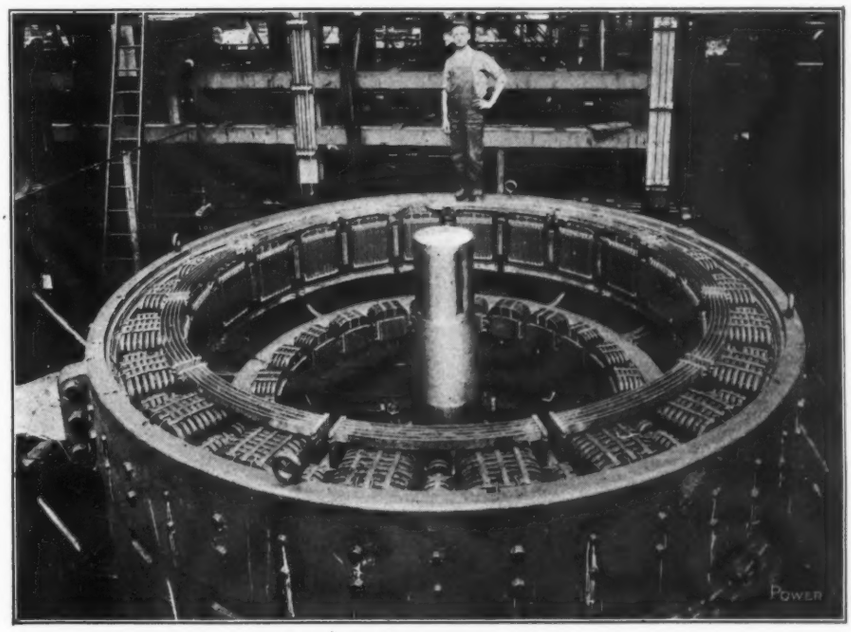


FIG. 4. WINDINGS OF 3000-KW. CONVERTER FOR N. Y. EDISON CO.

The converters deliver a normal direct-current voltage of 270, and are for 25-cycle, six-phase operation. The direct-current voltage variation obtained through the booster feature is 15 per cent. opposing and 15 per cent. boosting from the normal voltage, giving a total direct-current voltage variation of 30 per cent. These machines were made of the vertical type to conform in general construction to the other converters in the substations and start from the direct-current side.

Fig. 2 shows the detail construction of the machines. The converter armature and frame are mounted above the booster. The commutator is at the top of the machine and the collector rings at the bottom. The armature shown in Fig. 3 consists of a rotary-converter armature of the usual construction mounted on the same shaft with the smaller booster armature, which is connected in series with the converter armature so that when the booster field excitation is varied, the alternating-current voltage impressed on the converter armature will be decreased or increased accordingly.

The main or converter poles (Fig. 4) are shunt wound, and the copper grids imbedded in the main pole faces do not extend from pole to pole as in the ordinary machine but are cut off flush with the sides of each main pole; this construction is used on all commutating pole converters, which forms the most effective starting and damping winding. The booster poles are shunt wound, and the booster field is arranged for hand regulation.

A roller thrust bearing is arranged at the top of the pedestal to take the weight of the revolving element. The bearing rests on a plate which has a spherical seat carried on the pedestal so that perfect alignment is assured. The roller bearing can be taken out by removing the top plate of the machine. To assume the weight of the rotating part when it is necessary to remove the top plate, six 1¾-in. bolts are provided that turn through the lower portion of the pedestal flange. When necessary to take off the top plate, these bolts are screwed up until they raise the rotating element slightly and assume its weight.

Lubrication is effected with a gravity oiling system, the oil being forced up through the center of the pedestal and discharging at the top through a nozzle into a cylindrical chamber within the roller bearing.

Heating City by Electricity

Officials of the electric plant in Stavanger, Norway, have asked the city council's permission to electrically heat business houses and dwellings. Stavanger has a population of about 30,000, and 25,000 hp. can be developed by its water-power facilities.

According to present plans, no consumer will be allowed a consumption exceeding 100 hp. The price per horse-power per year will be only about $7 as the cost of production will be very low. The council also has under consideration the heating of Stavanger's public buildings by electricity.

Gas Power Department

Worth-while gas-engine and producer information treated in a way that can be of practical use

Some Recent European Gas Engine Plants

By Austin C. Lescarboura

In Europe the advantage of using the waste gases from blast furnaces and coke ovens is becoming more fully recognized, especially with the appearance of engines which have been especially designed to operate on the quality of gas obtained from such sources. Gas engines operating on blast-furnace gas are found to give as high as 28 per cent. efficiency, while the best steam engine or turbine would not produce over 15 per cent. Tests have shown that with the same quantity of gas, the gas engine will furnish double the power that would be produced by a steam plant where the gas is burned under boilers to generate steam. Smelting plants are accordingly adopting large gas engines largely for generating electricity or driving blowers.

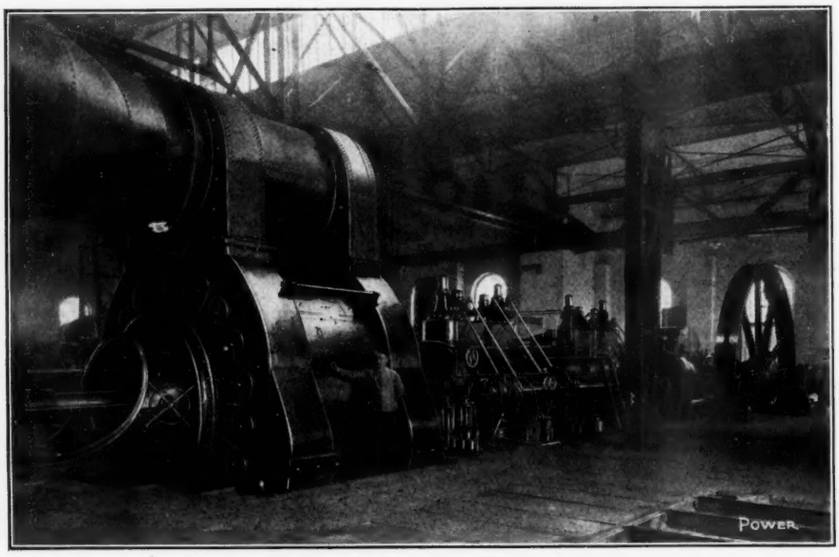


Fig. 1. Nürnberg Gas Engine and Blower, at Röchling Works

The gas from a blast furnace is said to represent about 34 per cent. of the total energy of the furnace. If this gas be burned under steam boilers which have a low yield, only approximately 4000 boiler horsepower can be obtained from a furnace producing 250 tons daily. The same gas in a gas engine would develop about 10,000 hp., according to results obtained with Nurnberg engines. Where the machines throughout the shops are steam operated, the loss in the piping is considerable for an extensive plant, and the economy of steam engines used on intermittent runs is low, so that probably not over 2000 hp. is realized from the total 4000 hp. of the gas-fired boilers. On the other hand, the 10,000 hp. from gas engines operating on one blast furnace, after deducting, say, 2500 hp. for running blowing machines, cranes, pumps and other machinery, leaves 7500 hp. to convert into electricity for operating rolling mills and other machines. This power may also be used in electric furnaces, or possibly be made a source of additional income by selling current.

The problem of operating gas engines from coke-oven gas is somewhat more complicated, owing to the different types of furnaces in use, and although the gas is not as suitable as that from blast furnaces, there are still several points in favor of using it in gas engines. From the waste gases of a recuperative coke oven burning 200 tons of coal per day, from 1500 to 1800 hp. can be obtained through gas engines. With the new gas producers of the Nürnberg type, using fine or waste coke which would otherwise be lost, considerable extra power can be obtained.

The Nürnberg gas engine is well adapted for operating blast-furnace blowers, and a typical installation of this kind is illustrated in Fig. 1, which shows the blower at the Röchling steel works, near Carlshütte, Germany. This plant also has two groups, each of 5000 hp., of Nürnberg engines operating on blast-furnace gas. The large blower is connected directly to a gas engine and has hollow disk pistons, allowing water-cooling when working at high pressures. As the blast-furnace blower has to run at variable speeds, the engine speed is controlled by changing the cutoff of the gas-inlet valve and by hit-and-miss governing.

An important installation of these engines is in the Georgs-Marie mining and metallurgical works, near Osnabrück, Germany, Fig. 2, which includes six gas engines, giving a total of 8990 hp. These engines are connected directly to direct-current dynamos, which furnish electricity

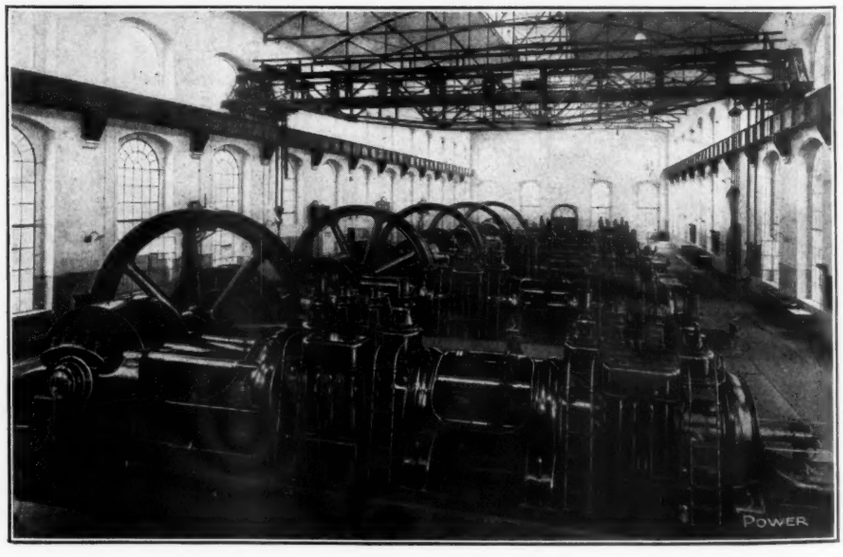


Fig. 2. Plant at Georgs-Marie Mine

for use on the premises. Another German plant using blast-furnace gas is the Rombach metallurgical works, at Lorraine, which has engines aggregating 29,-

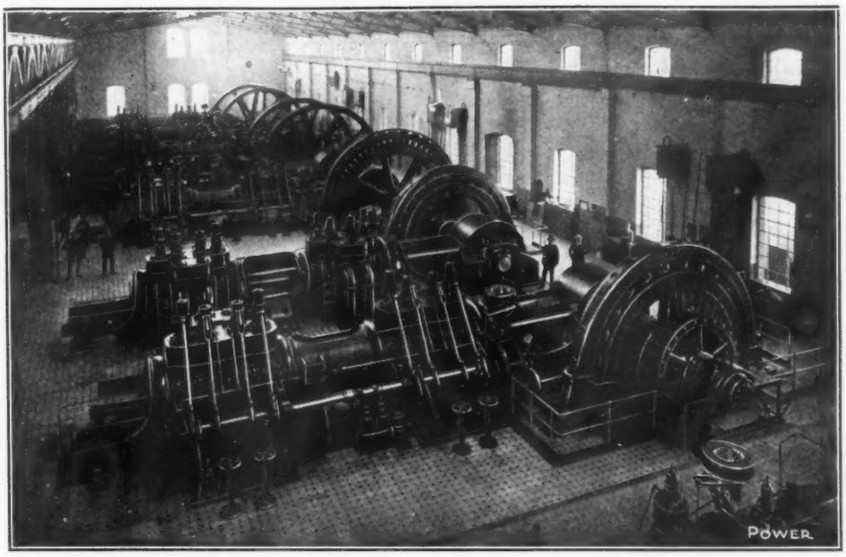


FIG. 3. PLANT OF ROMBACH METALLURGICAL WORKS

120 hp., shown in Fig. 3. Some of the engines drive generators having a combined output amounting to 11,500 kw., and the others are connected to blowers

Elyria Oil Engine

An oil engine embodying many of the advantages of the Diesel type, yet at a slight sacrifice in economy, avoiding the mechanical refinements, excessive weight and the auxiliaries of the latter, is being built by the Elyria Gas Power Co., Elyria, Ohio, in sizes from 25 to 150 hp.

Although the operating principle is similar to the Diesel, several departures have been made in its application. Chief among these is the use of lower pressures and an unjacketed cylinder head and false piston end, with which it is said to be possible to burn the heaviest fuels with a maximum pressure not exceeding 400 lb. per sq.in. without missed ignition, so common at light loads.

The two-stroke cycle has been adopted to decrease the weight and consequently the price per horsepower, and to simplify the construction from the standpoint of the user by eliminating the valves and valve-gear from the working cylinder. Although there is a tendency toward lower thermal efficiency, due to lower compression, this is compensated through having less jacketed surface exposed.

Some sacrifice would be expected in a modification of any well established type, and the Elyria engine has a fuel consumption somewhat greater than the standard four-stroke-cycle Diesel engine of the same size. The makers claim, however, that this is not due to any loss in thermal efficiency but rather to a lower mechanical efficiency, because of the extra work in scavenging the cylinder.

As Fig. 3 shows, there are two pistons —the working piston and the scavenging or differential piston; the displacement of the latter is approximately 1.9 times that of the former. The two pistons are separate castings held together by four studs. The wrist-pin is carried in the forward or differential piston, producing the effect of a crosshead, as all side thrust is relieved from the working piston. To take out the working piston requires only removing the cylinder head, which is free from piping, and the four nuts which secure the two piston castings together.

The piston head is a separate piece which tends to maintain a high temperature and incidentally permits symmetry of the piston casting. The six rings used are accessible for inspection by removing the cap over the inlet port at the top of the cylinder.

To provide air for injection, three stages of compression are employed; the first is effected by the differential piston and the second and third by a separate compressor eccentric-driven from the main shaft, as shown in Fig. 2. Through the pipe shown in this illustration, air is taken past the piston valve and into the differential cylinder. It is here compressed in the first stage to about 5 or 6 lb., at which pressure the scavenging is effected.

The larger cylinder of the compressor takes air at this pressure from the scavenging, or differential, cylinder and compresses to 175 or 200 lb.; this air is delivered to a receiver alongside the machine, which is also the starting tank.

The third stage air (that used for fuel injection) is taken from this middle-stage tank through the governor-controlled valve to the high-pressure cylinder of the compressor and thence direct to the injection valve. This pressure will vary from 500 lb. at light loads with easily atomized fuel, to as high as 1000 lb. per sq.in. with overloads and the heaviest fuels.

Among the advantages claimed for this means of air control over standard Diesel practice, are that the first-stage compression is delivered by the scavenging cylinder without extra mechanism; that only a short length of piping is needed and no tanks for storing high-pressure air; and that for all load conditions the air pressure and volumes are automatically controlled.

The air in the main cylinder is compressed to 400 lb. which is the maximum pressure in this cylinder as no explosion occurs. To provide against the contingency of loss of pressure in the receiver while the plant is idle, a small gas or

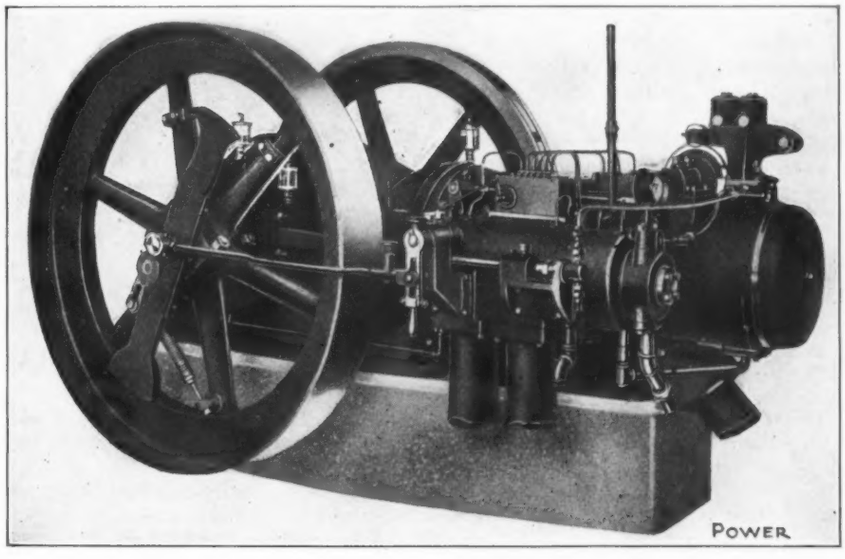


FIG. 1. GENERAL VIEW OF ELYRIA OIL ENGINE

gasoline engine and compressor are furnished with each installation.

The fuel pump is driven by an ordinary Rites governor in the flywheel, which varies the stroke of the pump plunger, thus proportioning the amount of fuel to the load. The driving mechanism allows disconnecting the governor and operating the pump by hand to supply oil for starting. Similarly in shutting down, the oil supply is thereby immediately cut off.

When starting the engine cold, gasoline is sprayed into the cylinder through the fuel valve and, to insure combustion, batteries, a vibrator coil and plug are provided. No commutator is used, consequently, a continuous shower of sparks is thrown into the cylinder, which serve to augment the heat of compression and insure burning.

Within 60 sec. from the first introduction of gasoline it is claimed the switch can be thrown out, the heavy oil immediately turned on and full load thrown on the machine. The working piston is lubricated from a force-feed pump, which also furnishes the small amount of oil required by the compressor cylinder. All important bearings, such as main bearings, crank-bearing eccentric, scavenging piston, or crosshead, and crosshead pin, are lubricated by a continuous oiling system. Oil from an overhead tank after filtering is fed to the bearings, from which it runs to a sump tank and is then pumped back to the overhead tank.

The cooling system is simple, having only one inlet and outlet. All water is admitted around the compressor cylinder from which it goes to the working cylinder and is there discharged. According to the manufacturer, with water entering at 60 deg. F., only 3 gal. per horsepower-hour is required.

This engine is being marketed under a fuel guarantee of 0.65 lb. of oil per brake horsepower at rated load and not to exceed 0.75 lb. at half load.

A Diesel Engine Explosion

By Arthur H. Allen

A singular accident occurred on July 10, at the municipal plant at Bray, a small town in Ireland. A Diesel engine of 50 hp. was being started up, when a violent explosion took place, killing one man outright, blowing a foot off the chief engineer and injuring his assistant. According to the latter, the compressed air in the starting reservoir had failed and, lacking means to compress a fresh supply, a 40-cu.ft. cylinder of compressed oxygen was obtained for starting the engine—a course recommended by the makers of the engine. The blast chamber was charged to 700 lb. pressure from this cylinder, and one of the starting reservoirs was also charged to about 350 lb. The assistant then started the engine in the usual manner, and, going on the platform, put the starting lever into the running position. He noticed that the engine did not appear to be running properly, but before he could ascertain what was wrong, the fuel valve in the cylinder cover exploded; the flame shot along the blast pipe and reached the blast reservoir, which then exploded also.

There was nothing unusual in the use of oxygen, although carbon dioxide is perhaps preferable, and doubtless if this gas had been used the explosion would not have occurred.

Several experts examined the plant after the explosion, and the general opinion was that it was due to the violent combustion of the oxygen with oil contained in the blast reservoir or in the passages connected with it. Some were of the opinion that using pure oxygen for starting was dangerous, although sanctioned by the engine builders. Without doubt the engine cylinder, the pipe connections, and the reservoirs were filled with air highly charged with oxygen—perhaps nearly pure oxygen—and the rise of pressure on ignition far exceded the normal pressure when working with air, overcoming the pressure in the pipes and reservoirs; but the fragments of the latter showed no indication of defective construction or material, and the necessary conclusion is that an explosion actually took place in the reservoir. The difficulty is to account for the presence there of volatile oil or combustible gas in sufficient quantity to explode.

Explosions have taken place in connection with the transmission of power by compressed air, due to using lubricating grease or oil, and apparently this case was similar. Presumably the oil had crept along the pipe into the air reservoirs from the air-compressor cylinder, or perhaps when the excessive pressure rise took place in the engine cylinder sufficient oil was blown back along the blast pipe to produce the result.

According to the latest information, there was no trace of oil on the fragments of the receiver, but this may have been due to the intense heat and violence of the explosion. That the connection from the blast receiver to the fuel valve was a copper tube 14 ft. long and only ⅜ in. in diameter, indicates that the explosion could not have been due to transmitted pressure, but flame could certainly travel along such a pipe. Normally, there is an almost continuous stream of air from the receiver to the fuel valve; therefore fuel oil could not creep along the pipe into the receiver. More probably the oil came from the air-compressor cylinder, the lubricating oil from which might reach the receiver either as vapor or by creeping.

In any case, the incident conveys a warning that the presence of oil in the air reservoirs is dangerous, and that in starting a Diesel engine in an emergency with "bottled gas," it is wise to use carbon dioxide rather than pure oxygen.

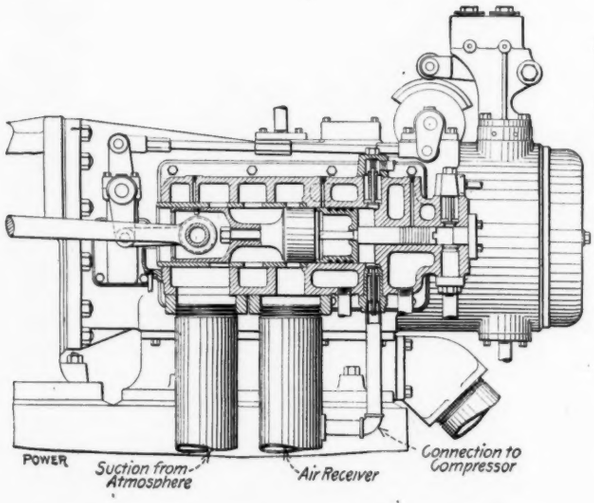


Fig. 2. Showing Section through Air Pump

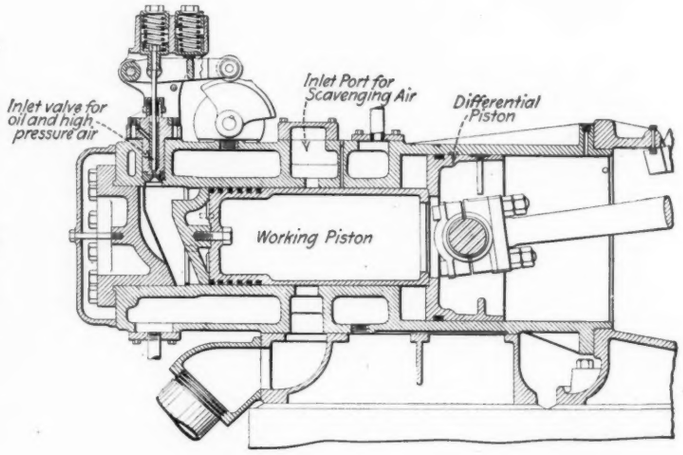


Fig. 3. Showing Section through Piston and Ports

Refrigeration Department

Principles and operation of ice-making and refrigerating plant and machinery

Means for Accumulating Refrigeration—III

By Charles H. Herter

When an ice-machine builder is requested to furnish a refrigerating plant to be operated for, say, 12 hours per day in summer, with no brine pump moving during the night, and the temperature is stipulated not to rise more than a certain number of degrees Fahrenheit during the stop, he resorts to the use of brine tanks. In these the brine is lowered in temperature when the machine is in operation or some ice is formed and in this way refrigeration is accumulated for use during the night.

In the second article it was shown that when the insulation is placed outside the building walls, or a brick lining is erected, they acquire low temperatures and act as barriers to the incoming heat, because a portion of this heat is expended in raising the temperature of the walls. A more common method for preventing a 3-deg. temperature rise when the machine is shut down for some time, which for many products is the limit of safe permissible variation, is to use brine-storage tanks. Even this is practicable only on a small scale. In large installations refrigeration is either maintained continuously day and night, or a large body of brine is cooled off during the day and circulated by a pump through pipes in the rooms during shutdown. With the latter, direct-expansion ammonia pipes are usually abandoned and the plant operated on the brine-pipe system.

Brine Storage Tank System

In the following a brine-tank equipment will be laid out for the 12,000-cu.ft. meat room referred to in the first article. The heat leakage into this room has been calculated at 300,000 B.t.u. per 24 hours. Besides maintaining the temperature of the room it may be necessary to cool each day one-fourth of the contents, or 12,500 lb. of meat, received from refrigerator cars, through a range of 15 deg., which requires

$$12{,}500 \times 15 \times 0.8 = 150{,}000\ B.t.u.$$

An allowance of 50,000 B.t.u. will cover the additional work required for renewal of air, heat due to presence of workmen, lights, etc. The total work in the day time will be 350,000 B.t.u. and at night 150,000 B.t.u.

Brine-storage tanks are usually operated without ice being formed therein intentionally. While by taking advantage of the latent heat of fusion of frozen brine much more refrigeration can be stored per cubic foot of brine, certain difficulties make this plan undesirable for most plants. However, the theoretical analysis may be interesting, and will be given later.

For economy, a plant should always have enough cooling surface to allow operating with a suction pressure and evaporating temperature as high as permissible. In the present case, owing to the need of cold brine in tanks, this cannot exceed 15 lb. gage, the ammonia vapor being then at —1 deg. F.; otherwise the temperature differences become so small that the brine tanks and cooling pipes require inconveniently large surfaces, and the plant is not large enough to warrant operating with two different suction pressures.

During the night the air rises from 32 to 35 deg. and the calcium-chloride brine from, say, 6 to 22 deg. Thus a cubic foot will take up

$$(22 - 6) \times 52 = 832\ B.t.u.$$

the necessary brine capacity being

$$\frac{150{,}000}{832} = 180\ cu.ft.$$

which is 1 cu.ft. per 66⅔ cu.ft. of room volume. To hold this quantity, use six tanks each 10 ft. long, 12 in. wide and 3 ft. deep. Longer tanks are inconvenient for transporting and erecting, while assembling in place is usually out of the question, owing to the lack of working space in the bunkers or coil lofts. The cooling surface of the four walls of each tank is 66 sq.ft., or a total of 396 sq.ft. During the night the true mean temperature difference between the air and the brine is 18.85 deg. The coefficient of heat transmission k in B.t.u. per square foot per hour per degree temperature difference will therefore be

$$\frac{150{,}000\ B.t.u.}{12\ hr. \times 396\ sq.ft. \times 18.85\ deg.} = 1.674$$

The above method of computing the available tank cooling surface and coefficient k is as yet not followed by all refrigerating engineers. Those who shirk going into "details" or are anxious to hand in an attractive bid, usually specify only one or at most two tanks for the whole body of brine. Manufacturers' illustrations show only one tank, although the necessary cooling surface is not then obtained, the dead brine remote from the side of the tank not being able to do its share in absorbing heat. With the weak air circulation realized, each square foot of tank surface can only absorb heat at the rate of from 1 to 2.5 B.t.u. per degree per hour, the exact value varying with the amount of difference and extent of frost on the surfaces. In the foregoing example a value between these two figures has been taken.

For satisfactory results it is well to observe the temperature of the brine as it offers a convenient means for determining the work done. For this a long-stem thermometer is very useful, but if not available, an ordinary short thermometer may be set into a small open-top tin can fastened to the end of a stick in the manner of a milk measure, and the whole submerged. By keeping the can for a few minutes at a certain spot the true temperature prevailing there will be obtained because the brine in the can will then have acquired the temperature of the particular portion of brine in the tank.

If the thermometer admits of close reading, a difference in temperature will be detected at various points of the tank owing to the absence of good circulation. When stirring the brine, an average temperature is obtained. The purpose of the can is to keep the bulb of the thermometer in contact with brine which has acquired the temperature of the brine whose temperature is to be ascertained; otherwise the bulb on being lifted out of the tank and exposed to the air will at once become cooled, due to evaporation. It also prevents the thermometer from being influenced by a stratum of possibly colder brine encountered while on the way to the surface. This method of taking the temperature of liquids can be used also with freezing tanks, storage vats, etc.

A pipe connection should be arranged near the top edge of each tank, unless they are intercommunicating when a single pipe will do, not so much to facilitate filling as to serve as an overflow; a similar connection with a valve should be provided for draining. Tanks must always be at least 6 in. from the nearest wall to allow room for air to circulate. The tanks in the bunker overhead should be so arranged that the natural flow of the air is lengthwise with the tanks and not at a right-angle thereto.

A substantial insulated bunker floor is usually provided, even where no tanks are used, inclined down toward the down shaft at a slant of ½ in. per foot or more, to allow the drip water from

the pipes on thawing to get to the drip gutter as fast as possible to avoid humidifying the air, and from there out through the waste pipe, which is 2 in. or larger. This pipe must have an easily accessible waste-pipe trap under the bunker to prevent escape of cold air. The bunker floor must be water-tight to protect the goods stored and to keep moisture out of the insulation.

For covering the floor, zinc, sheet lead, copper or galvanized iron, with either white or no painting, is preferable to built-up roofing, because it is not so easily pierced and is capable of absorbing much less radiated heat. With the air temperature at zero and below, the metal covering, if not free to move, is apt to cause trouble owing to contraction, and then a calked floor, roofing or asphalt may be used.

The object of insulating the bunker floor is to prevent dripping at the under side, and to assist the air circulation. As the cooling devices rest on timbers directly above the bunker floor, the timbers laid level and parallel to the air flow, the floor becomes chilled, and unless insulation, 2-in. thick corkboard or its equivalent, with no air spaces, is used to prevent the underside of the ceiling from getting cold, the fresh warm air entering through the door will deposit its moisture directly on the ceiling instead of on the frosted surfaces, and a "wet ceiling" is a nuisance. In primitive refrigerators the cold air descends from spaces between the bunker-floor joints, the air eddying around in the upper part of the storage space to the detriment of uniform temperature.

A positively guided circulation of air should always be provided for. The cold air, to do effective work, must be admitted to the storage space at a low level, sweep over the goods, become warmed and gradually rise to the bunker to be recooled. With no fan, circulation is brought about by the difference in temperature of the cold and warm air, but as this difference is only 1 to 2 deg., the difference in height of the respective columns of air must be taken advantage of. The simplest way to do this is to provide an apron, insulated with, say, 1-in. corkboard, forming with the wall a down shaft reaching within 2 ft. of the floor. On the opposite side is a similar apron, insulated with 2-in. corkboard to prevent early cooling of the warm air, forming the up-duct and extending only from the bunker floor to within a distance of the ceiling, leaving an area equal to the free area of the up-duct. This duct should be along the warmest wall of the room where the air rises naturally, so as to favor the natural air circulation.

It is also better if the underside of the bunker floor, with either no beams projecting or with the beams parallel to the air flow, slants from the cold-air toward the warm-air duct. Thus the vertical distance from the cold-air inlet to the warm-air outlet is as great as possible, resulting in a noticeable energetic air circulation which leaves the room dry and sweet.

The up-and-down air duct areas should each equal not less than 10 and, if possible, 15 per cent. of the ceiling area. In the room under discussion, measuring 20 x40 ft., a down shaft, 40x3 ft., should be provided in the center of the room, and one up shaft, 40x1½ ft., along each side wall. Instances might be cited where in rooms exceeding 16 ft. wide only one up-duct and one down-duct, each 12 in. wide, were provided and where the temperature in the storage space remained 10 or more degrees higher than in the loft, because the circulation was choked.

Sometimes the brine tanks are made narrower than 12 in. and hung all around the walls. This saves the cost of the insulated bunker floor, drip gutters underneath being sufficient to catch the meltage, but the air circulates around in eddy currents and wall space must be sacrified. It is, however, the only arrangement that can be used when the room is not high enough for a bunker.

Occasionally several brine-storage cylinders are hung from the ceiling or walls, made of 12 in. spiral riveted pipe and containing a loop of ammonia pipe passing through stuffing-boxes in one of the heads. This arrangement is effective, but wooden gutters lined with sheet metal must be used to catch the drip. The cylinders being closed, the density of the brine remains unaltered. Like all refrigerating surfaces, the cylinders must be kept about 12 in. from the ceiling to prevent condensation thereon of the vapor in the air. A pet-cock to show overfilling should be used.

As during the day, the brine tanks contribute to the work of refrigerating, sufficient submerged cooling piping must be provided to abstract, say, 300,000 B.t.u. every 12 hours. The logarithmic mean temperature difference between the ammonia and brine is 13.45 deg., and the heat transmission for 1¼-in. ammonia pipe (not using the "flooded" or gravity-feed system of circulation) submerged in still brine is about 4 B.t.u. per hour per degree per lineal foot. Accordingly

$$\frac{300{,}000\ B.t.u.}{12\ hr. \times 13.45 \times 4} = 465\ ft.$$

of pipe is necessary, or 78 ft. per tank Continuous electric-welded oval 8-ft. coils can be used, wound 8 in. on centers, 5 pipes high, 5 in. on centers vertically.

The remaining 200,000 B.t.u. of day work can be done by exposed direct-expansion ammonia pipe. Taking the average temperature difference at only 30 deg., and the heat transmission at 1.1 B.t.u. per lineal foot of 1¼-in. pipe per hour per degree difference, the amount of pipe needed is

$$\frac{200{,}000\ B.t.u.}{12\ hr. \times 30\ deg. \times 1.1\ B.t.u.} = 505\ ft.$$

As the frost on this piping can thaw off every night, no additional piping need be reserved for defrosting in day time.

For flexibility in operation a separate circuit should be arranged for the submerged and for the exposed set of piping, each set fed by one expansion valve.

It is to be hoped that the above rational method of arriving at the amount of piping will ultimately supersede the prevailing rule-of-thumb custom of using "ratios." By factors expressing ratios are meant arbitrary allowances, such as cubic feet of brine, or cubic feet of space per foot of pipe, feet of pipe per ton of refrigeration, etc. Such methods are unscientific, because no set of conditions can be considered as standard. The transfer of heat to a pipe is influenced only by k, the coefficient of heat transmission, and by the mean difference in temperatures.

Congealing Tank System

As already stated more refrigeration can be stored up per cubic foot of brine volume in tanks if a portion of the brine is frozen. The tanks can be thinner, which is an advantage if they must be hung along the walls on account of low head room.

To operate the machine with the same economy as with the brine-tank system first calculated, the suction pressure must be not less than 15 lb. gage, giving an evaporating temperature of — 1 deg. F. in the expansion coils. When determining the dimensions of tanks in which ice is to be formed, the following experience with the standard can system of making ice should be kept in mind:

In the fall or winter, when the demand for ice is less than the daily capacity of the factory, the machine is sometimes shut down after all cans are frozen solid, supposing the ice-storage room to be already full. If meantime the brine is allowed to warm to 32 deg., the blocks in the cans will commence to melt. Ice being lighter than water in the proportion of 57.4 lb. to 62.4 lb. per cubic foot, the ice will soon float, so that 6 in. of water might be under the melting block, and an average of 1 in. of water around its four sides.

If, now, the brine is cooled to save the ice, the upper part of the blocks will freeze to the can before the water in the bottom has solidified. The water during freezing expands, and being confined the cans will first be bulged out of shape, causing the seams to leak, and when freezing is continued, rupture must result. Cases are known where several hundreds of cans have been burst in this manner—to the discomfort of the engineer, for a good steel galvanized can for 300-lb. blocks costs about $3.50. The remedy is to keep the brine agitated and not let it get over 28 deg. F., or not

to freeze up the cans in the first place.

To guard against the trouble, the congealing tanks must be built so that the requisite quantity of brine-ice will grow on the cooling coils at a safe distance from the sides. For example, suppose the tank to be 5 in. wide inside, 10 ft. long and the brine 3 ft. deep. These tanks are usually of galvanized steel $\frac{1}{16}$ to $\frac{1}{12}$ in. thick, surrounded by pairs of angle irons every 2 ft. to keep the tanks in shape. Into such a tank a direct-expansion cooling coil of 1¼-in. ammonia pipe can be placed, the bends at the ends being made to a radius of 6 in. to the center of the pipe. As it is necessary to crowd in as many loops as possible the pipes are not run parallel, but zigzag like a steel band folded up. Thus a coil can be used at least 8 pipes high and 9 ft. 6 in. long, the total submerged length being about 80 ft. The brine volume of one tank is 12.5 cu.ft. The four walls of each tank represent 62.5 sq.ft. of effective heat-absorbing surface; six tanks have 375 sq.ft. The duty of each square foot during the night is

$$\frac{150{,}000\ B.t.u.}{375 \times 12\ hr.} = 33.3\ B.t.u.\ per\ hour$$

Taking for k the value already applied to brine-storage tanks, the temperature difference necessary is

$$\frac{33.3}{1.674} = 19.89\ deg.$$

which is about 1 deg. more than with unfrozen brine. To satisfy this condition, the brine temperature may be 8 deg. in the evening and rise to 19.4 deg. by morning. Each of the six tanks must then absorb

$$\frac{150{,}000\ B.t.u.}{6} = 25{,}000\ B.t.u.$$

As 11.58 cu.ft. of salt brine taking up

$$19.4 - 8 = 11.4\ deg.$$

abstract only

$$11.58 \times 11.4 \times 58.4 = 7709\ B.t.u.$$

the deficiency of

$$25{,}000 - 7709 = 17{,}291\ B.t.u.$$

must be supplied in the form of latent heat when the brine-ice melts at 8 deg. F. The writer knows of no tests made to ascertain this quantity. The latent heat of fusion of a pound of brine-ice is certainly less than 144 B.t.u., the latent heat of pure water ice, because less than a pound of water is present; on the other hand, probably salt crystals are expelled in the process of freezing. In the absence of exact data, the following calculation is probably close enough for the purpose:

For an 8-deg. F. freezing point use a 17.5 per cent. solution of salt, not chloride of calcium because the heat capacity would be 8 per cent. less. A cubic foot of this solution will weigh 70.56 lb., 12.35 lb. of which is dry salt, leaving 58.21 lb. of water. The latent heat of this is

$$58.21 \times 144 = 8382\ B.t.u.$$

per cubic foot of solution; but when frozen, the volume is about 8½ per cent. larger, thus the latent heat becomes

$$\frac{8382}{1.085} = 7725\ B.t.u.$$

per cubic foot of brine-ice. For 17,291 B.t.u., 2.237 cu.ft. must be accumulated on the 80 ft. of 1¼-in. pipe. This means 48.25 cu.in. per lineal foot, equivalent to a coating of ice uniformly 0.564 or $\frac{9}{16}$ in. thick.

The next step is to ascertain whether the 80 ft. of pipe is adequate to do both the day and night work. After the 12-hour shutdown all the brine-ice will have melted and warmed to 19.4 deg. F. This brine must first be cooled again to 8 deg.; requiring 7709 B.t.u. per tank. But while this heat is being abstracted, more heat is being supplied to the brine by the frosted tank surface, which extends the cooling period to about three hours, as will be proved.

In three hours the tank surface absorbs

$$62.5\ sq.ft. \times \left(32 - \frac{19.4 + 8}{2}\right) \times 1.674 \times 3 = 5744\ B.t.u.$$

Adding this to the 7709 B.t.u. brine cooling makes the total 13,453 B.t.u. The submerged piping can absorb heat at the rate of

$$80\ ft. \times \frac{19.4 + 8}{2} \times 4\ B.t.u. = 4384\ B.t.u.$$

per hour, and

$$\frac{13{,}453}{4384} = 3.07\ hr.$$

As during the remaining nine hours of running the brine is at 8 deg. and the air at 32 deg., the tank surface may be credited with absorbing

$$62.5\ sq.ft. \times (32 - 8) \times 1.674 \times 9 = 22{,}600\ B.t.u.$$

Operating now with only 9-deg. temperature difference, the capacity of the 80 ft. of pipe is reduced to

$$80 \times 4 \times [8\ deg. - (-1\ deg.)] = 2880\ B.t.u.\ per\ hour$$

$$\frac{22{,}600}{2880} = 7.85\ hr.$$

of work. This leaves only 1.1 hours for congealing the brine, which alone was found to require 17,291 B.t.u. per tank. Now the heat conductivity through the wall of an extra-heavy 1¼-in. iron pipe covered with 0.564 in. of brine-ice, not water-ice, may be calculated at

$$1 \div \left(\frac{0.194}{476} + \frac{0.564}{12}\right) = 21.1\ B.t.u.\ per\ hour$$

and that through the same pipe wall, but covered with 0.564 in. of salt brine of 1.131 specific gravity at 60 deg. F.

$$1 \div \left(\frac{0.194}{476} + \frac{0.564}{3}\right) = 5.3\ B.t.u.\ per\ hour$$

The comparative conductivity in the two cases is therefore as 3.98 is to 1, and since k for 1¼-in. ammonia pipe to brine is 4 B.t.u. per hour per lineal foot, k for ammonia to brine-ice should be 15.92. To prove this estimate correct this value may be compared with the heat transmission secured in the process of can-ice making:

With brine 9 deg. below 32 or at 23 deg. F., 0.564 in. of ice is formed in

$$\frac{28 \times 0.564^2}{9\ deg.} = 0.99\ hr.$$

The heat abstracted per square foot of ice 0.564 in. thick is about

$$\frac{144 \times 0.564}{30.1} = 2.7\ lb.$$

$$2.7\ [(68 - 32) \times 1 + 144 + (9 \times 0.5)] = 498\ B.t.u.$$

The mean temperature during the process is

$$\frac{\left(\begin{matrix}2.7[(50 - 32) \times (68 - 32) + \\ (9 \times 144) + (4.5 \times 4.5)]\end{matrix}\right)}{498} = 10.65\ deg.$$

Consequently

$$k = \frac{498}{10.65} = 46.8\ B.t.u.$$

per square foot. This is for 1 sq.ft. of freezing surface per square foot of ice sheet. The surface of one lineal foot of 1¼-in. extra-heavy pipe based upon its mean diameter is only 0.377 sq.ft., it should therefore absorb

$$0.377 \times 46.8 = 17.64\ B.t.u.$$

per degree difference, which is 1.72 B.t.u. better than 15.92, the figure assumed, and is unquestionably due to the influence of agitation in the freezing tank, which increases the rate of heat transfer.

Each lineal foot can therefore abstract

$$15.92 \times 9\ deg. = 143.28\ B.t.u.$$

per hour, or 157.6 B.t.u. in the 1.1 hours available for freezing. The 80 ft. will thus store up

$$157.6 \times 80 = 12{,}608\ B.t.u.$$

of latent heat, leaving a shortage of

$$17{,}291 - 12{,}608 = 4683\ B.t.u.$$

It will therefore be advisable to add a ninth pipe to the coil of each tank, which will do freezing for a total period of, theoretically,

$$\frac{4683}{9.5\ ft. \times 143.28} = 3.44\ hr.$$

The day work has been figured at 350,000 B.t.u. During the first three hours each tank absorbs 5744 B.t.u., and during the remaining nine hours, 22,600 B.t.u., total 28,344, or 170,040 B.t.u. is the work of the six tanks, leaving 179,960 to be absorbed by exposed direct-expansion ammonia piping. Using the same values as with the brine-tank plant, the length of the 1¼-in. piping required is

$$\frac{179{,}960}{12\ hr. \times 30\ deg. \times 1.1} = 454\ feet$$

The tabular comparison shows plainly that, contrary to usual expectations, there

is practically no difference in first cost and operating expense between the two systems. With the storage tanks it is easy to make the brine dense enough not to freeze, and when the brine has been cooled to 6 deg. F. in the above example the engineer knows that he can stop. But with the congealing tanks it is a trick to keep the brine always just dense enough to freeze at 8 deg. No one can tell whether sufficient brine has been frozen, or whether the thin tanks will be bulged out of shape, due to uneven freezing.

A COMPARISON OF BRINE STORAGE AND BRINE CONGEALING TANKS

	Brine Storage Tank System	Brine Congealing Tank System
Operating period, hours daily	12	12
Ammonia suction pressure, lb. gage	15	15
Number of tanks required	6	6
Size of tanks	10x3.5x1 ft.	10x3.5 ft.x5 in.
Effective tank surface, sq.ft	396	375
1¼ inch piping, submerged, ft	465	537
1¼ inch piping, exposed, ft	505	450
1¼ inch piping, total, ft	970	987

The calculations herein, which are more intricate with congealing tanks than with brine-storage tanks, prove that the limitations imposed by the low coefficient of heat transfer prevent a coating of more than ¾ in. uniform thickness of brine-ice to be formed on the pipes. The amount of refrigeration that can be accumulated is therefore much less than that corresponding to a tank full of ice; on the other hand, the tanks, if preferred, can be decreased in width to 3 in. As the brine is constantly absorbing moisture from the air and from frosted branch pipes, it becomes diluted and freezes at a higher temperature than desired, it being too troublesome to maintain the solution at a fixed strength.

It has been suggested to fit covers on top of these tanks to prevent the admission of moisture, but it is impossible to prevent this entirely; moreover, the removal of such moisture helps to improve the preserving quality of the cold air, for which purpose direct-drying agents, such as lumps of chloride of calcium, are often used. It is advisable, however, to prevent foreign moisture, such as comes from thawing pipes, from dripping into the brine. For these good reasons brine-storage tanks are seldom operated as congealing tanks. In drinking-water systems ice is frequently allowed to collect on the submerged cooling pipes, 144 B.t.u. being then stored up for every pound of ice so formed.

Liquor in the Cooler

Some textbooks state that there should not be any liquid in the cooler, but the orders here are to keep just enough liquid in the receiver so that the outgoing line to the expansion valve is sealed, and at the same time maintain as much liquid in the cooler as possible. I would like to have this subject explained thoroughly.

Is there any cheap substitute for mercury that can be used in thermometer wells? These questions were recently asked by a correspondent and the following answers may be of general interest:

The best practice in operating brine coolers or refrigerating apparatus of any kind, is to flood it with liquid ammonia as much as the construction of the plant will allow. For instance, with a shell-type brine cooler the maximum efficiency will be obtained if the liquid ammonia in the cooler is carried at as high a level as possible consistent with the proper operation of the ammonia compressor. The presence of too much or too little liquid in the brine cooler to fulfill the above requirements can be determined from the temperature of the discharge from the ammonia compressor. For a suction pressure of about 16 lb. per sq.in. gage, and a condenser pressure of 185 lb. gage, the discharge temperature should be about 250 deg. F. With too little liquid in the cooler this temperature will rise and with too much liquid, will fall. Different suction and condenser pressures will give other discharge temperatures, but the proper figure can be approximated by remembering that for a constant condenser pressure the discharge temperature increases with a decrease in the suction pressure and decreases with an increase in the suction pressure. For a variable condenser pressure and constant suction pressure the discharge temperature varies with the condenser pressure. For example, for a 20-lb. back pressure and 185-lb. condenser pressure the proper discharge temperature is about 235 deg. F. For a 10-lb. suction pressure and 185-lb. discharge pressure, the proper discharge temperature is about 270 deg. F. For a 20-lb. suction pressure and 165-lb. condenser pressure the proper discharge temperature is about 215 deg. F. and so on.

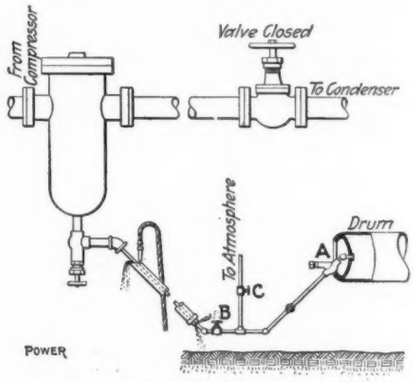
A cheap substitute for mercury in thermometer wells is oil. The oil must be selected so that the temperature range in the mercury well under consideration is not above or below the flash point and the congealing point of the oil respectively, that is to say, for measuring low temperature, cold test oil must be used, and for measuring high temperatures, high flash point oil.

CORRESPONDENCE

Home Made Ammonia Condenser

Last fall I had occasion to withdraw the ammonia from a 10-ton refrigerating system, the condenser of which was out of repair. The lessee of the property did not care to go to the expense of repairing it, so I made the condenser shown in the sketch and succeeded in saving nearly all of the ammonia.

I blew out the oil separator in the discharge line from the compressor, and put a 45-deg. elbow on the 1¼-in. horizontal pipe leading from the angle blow-off valve. At this point I reduced to a ⅜-in. pipe and ran it diagonally to the ground, a distance of about 9 ft. I placed the small pipe inside a piece of 1½-in. pipe, capped on the lower end, with a hole drilled in the cap large enough to allow the ⅜-in. pipe to pass through and leave about 3/32-in. clearance all around. The ⅜-in. pipe was then connected to an empty ammonia drum and a tee and riser to atmosphere so placed that when the drum was full I could shut off the ammonia by the valves *A* and *B* and let that contained in the pipe between the two valves escape through valve *C*. This prevented any ammonia coming in contact with the hands when the union was broken. The drum was placed on scales so that the amount entering could be easily weighed.



HOME-MADE AMMONIA CONDENSER

A hose was placed at the top of the jacket and allowed to discharge just fast enough to overflow. The compressor was a single-acting two-cylinder machine and by cutting out one side and running very slow I was able to obtain good results. It being late fall I had the advantage of good cool water for condensation.

G. B. LONGSTREET.

Somerville, Mass.

"A cubic foot of water heated to the temperature of steam under 70 lb. pressure contains as much energy as a pound of gunpowder," says a contemporary. Those operating old and corroded boilers might well take this to heart.

Issued Weekly by the
Hill Publishing Company
JOHN A. HILL, Pres. ROB'T MCKEAN, Sec'y.
505 Pearl Street, New York.

Monadnock Bldg., Chicago.
6 Bouverie Street, London, E. C.
Unter den Linden 71—Berlin, N. W. 7.

FRED R. LOW, Editor.

Correspondence suitable for the columns of POWER solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $5 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 21 Shillings.

Entered as second class matter, December 20, 1910, at the post office at New York, New York, under the Act of March 3, 1879.

Cable address, "POWPUB," N. Y
Business Telegraph Code.

CIRCULATION STATEMENT

Of this issue 30,500 copies are printed.

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

Contents

Page

Measuring Movement of a Steam Main 288
The Myrawatt, a New Power Unit... 289
Jersey City High School Power Plant 290
Girth Seam Protector..... 292
Rateau-Smoot Low Pressure Turbine 293
Shaft Governors..... 294
Crosshead Pressure on Guide..... 296
Moisture in Exhaust Steam..... 296
Ventilated Furnace Arch..... 297
An Economical Trapping System.... 297
Uehling CO_2 Meter Improvements... 297
Synchronous Booster Rotary Converters with Compound Interpoles 298
Some Recent European Gas Engine Plants 300
Elyria Oil Engine..... 301
A Diesel Engine Explosion..... 302
Means for Accumulating Refrigeration—III 303
Liquor in the Cooler..... 306
Home Made Ammonia Condenser.... 306
Editorials 307-308
Readers with Something to Say: Simple Valve Reseating Device.... Broken Stud Buckles Piston Rod ....Direction and Amount of Strain on Pins....Isolated Plant Management....Engineers' Examination Questions....International Standard for Flanged Fittings....
A Handy Stud Driver.....309-310
Questions Before the House: Mr. Jacobs' Condenser....Crank Position on Shafts....Submerged Flotation....The College Graduate and Practical Experience....Failure of Boiler Tubes....Things Commonly Wrong .... Hoarding Knowledge Hinders Progress..311-313
Inquiries of General Interest..... 314
Study Questions..... 315
Old Time Hoisting Engine..... 316
The Expert and the Engineer..... 316
Cylinder Lagging and Economy..... 317
Interesting Diagrams..... 319
Care of Governors..... 320
Kerr Economy Steam Turbine..... 320
Pump Valve Reseating Machine..... 322

POWER

New York City's Smoke

"Why should it be necessary to exhort the Board of Health to do its duty in the matter of quelling the smoke nuisance?" asks the New York *Times*. Architects of the city, according to the *World*, state that "New York will become as black as London unless a stop is put to the soft-coal smoke nuisance." The "increasing and practically unrestricted use of bituminous coal in the public-service power plants and large factories, apartment houses and Municipal, State and Federal buildings" is vigorously condemned.

The real reason for this is that the city has no sane system of looking after the cause of its affliction. It does not use, as far as we can ascertain, a chart such as the Ringelmann to determine the density of smoke that an offending chimney emits. This is left to the discretion of inspectors of the Department of Health, who, by the way, are not strictly smoke inspectors, as such duty is only incidental to others that they perform. Think of it; the world's second largest city smoke-inspectorless and wondering why it is smoky!

Considering that some of the public buildings are the greatest offenders it is no wonder that the smoke nuisance is general and on the increase. And no one is to blame but the city.

Most soft coals, except the high-grade semibituminous sorts, are cheaper than anthracite. Besides, due to its higher quality, the price of anthracite is kept high by its slow supply into the city. The introduction of mechanical stokers continues to increase and so, too, must the use of soft coal.

The smoke-inspection department of Chicago has made elaborate experiments in the smokeless combustion of many grades of coal in many kinds of furnaces. It also coöperates with the plant owners, giving expert advice as to the kind of coal and furnace best suited for the work. As told editorially (Nov. 7, 1911), Boston's smoke-inspection department does the same thing.

Heretofore in Chicago a chimney emitting smoke of No. 3 density (Ringelmann chart) for 7 min. during an hour was considered a nuisance. The total quantity of smoke was not considered; hence some owners were likely to be unjustly punished. Now observation will be made on a given stack every 15 min. throughout an entire day and the average density thus determined. If smoke of more than 2 per cent. density is emitted, the owner is appealed to by being shown that other plants with similar equipment are doing considerably better.

The smoke-inspection department of Chicago is there to advise and assist owners to obtain smokeless combustion and not to hale them before the court until these measures have failed.

New York may well take a few lessons from Chicago, and then demonstrate that it knows how to handle the smoke nuisance.

Who is an Engineer?

The old question as to who should be called an engineer has, like the proverbial bad cent, again "turned up." The daily press has voiced its opinion and still we are as far from a satisfactory conclusion as we were when the British military authorities in 1802 changed the title of "chief engineer" to "inspector general" of fortifications.

A correspondent in *Engineering News* suggests giving the name "energier" to those who hold degrees in mechanical and other lines of engineering, to distinguish them from those "who can use a monkey wrench and keep an engine running." In defense of the term "energier" the correspondent states: "The word already has a prototype in 'financier' (also a man of brains) and would not require much 'accustoming.'"

The parenthetical inference is that a man who can "keep an engine running" has little or no brains. If those engaged in modern power-plant practice are alluded to, the inference is the most effective boomerang that has come to our notice in some time. As for the term

"energier," it could as correctly be applied to a prize-fighter as any grade of engineer. The fighter skillfully directs and controls much energy, but there is little of the Greek "gennao," to beget or produce; or the Latin "inginium" or the English "ingenuity," about his work.

There was a time, before the advent of the Corliss engine, the problems of extensive high-tension electrical generations, steam-turbine practice and the chemistry of the boiler room, in a word, efficient power-plant management, when such engineering consisted chiefly in shoveling coal and "keeping an engine running" regardless of how it was running. That day has gone, and with it has gone that kind of an engineer—the engine-man, as our English cousins term him. It is ludicrous to even imagine a man in charge of modern power-plant equipment who can do little more than handle a monkey wrench, or who is, according to the correspondent's intimation, a man without brains.

There are men in plants who are mere starters and stoppers. They are known as such in the engine room and elsewhere. They are becoming more and more extinct and must continue to become so in the light of power-plant engineering progress.

The "Lusitania's" Turbine Troubles

A few hours after the "Lusitania" left Liverpool on a recent Western trip, one of her forward port turbines gave considerable trouble. This, according to the daily press, was due to a hot bearing. A passenger, in a position to know, states that the accident wakened nearly all on board and that the noise was caused by the tearing to pieces of the turbine blades.

This sounds more reasonable. A hot bearing would not disturb the whole ship or noncommission the turbine until the vessel had again reached Liverpool to enable the Parsons Company to make the necessary repairs.

Early in June this same turbine, we understand, stuck fast shortly after the vessel left the English port. The exigencies of the service do not allow the ship's crew or others time enough to make substantial repairs, and the recent accident may have been the direct result of inadequate correction of the last.

The trouble is probably due either to insufficient clearance between the periphery of the wheel and casing, or is the result of erosion and breaking of a blade or blades, which obviously work havoc in any turbine. The wheel in a Parsons turbine revolves in a medium of high density at the admission end. This means very high friction of the wheel against the medium and also leakage of steam which increases with the clearance between the rotating and stationary parts. This calls for a minimum clearance, and any appreciable reduction of it as caused by an excessively worn bearing will, if not remedied in time, permit contact.

The total number of vanes is also very high and the rotating and fixed blades increase in radial length and also in width as the exhaust end is approached, to pass the increased volume of steam.

Assume a common wooden lath mounted on a spindle as a turbine blade is mounted, except that the outer end of the lath is not held by shrouding. Let the lath be subjected to a high wind velocity. It will vibrate considerably and, if the wind velocity is high enough, the lath generally will break near the spindle. If the length of the lath is increased the danger of breakage is proportionately increased for the same wind velocity. The same action takes place in a turbine and, while the shrouding helps protect the blades against breakage, the vibration tending to break or loosen them from the spindle is nevertheless present.

It may be policy to delude the public about such happenings, but to endeavor to "pull the wool" over the eyes of engineers is not commendable. The Parsons is a good turbine, but confidence in it is not encouraged by concealing from engineers the troubles encountered in its operation.

False Economy

The superintendent of a large concern became interested in the efficiency of the power plant and decided to search into and stop the wastes. The wastes were more imaginary than real, however, as the engineer was thoroughly competent and obtained admirable economy. He belonged to engineering organizations from which he borrowed indicators, Orsats, etc., and he made good use of them in improving his plant.

This was all unknown to the superintendent, so he ordered the engineer to take indicator cards from all the engines every day. Later he learned a little about the diagrams and complained about poor compression, late cutoff and a variety of other defects that never existed. Naturally the engineer tired of this uncalled for criticism, knowing the engines were operating most economically. To put an end to it, he made tin templates of the diagrams that escaped criticism and thereafter all diagrams submitted to the superintendent were drawn from these templates. They were satisfactory, of course, and everybody was pleased.

The superintendent's attitude was an insult to the engineer, either way it may be taken, for it implied no confidence in his ability, or else presupposed that he would not do his best unless watched. The interference, amounting almost to persecution sometimes, that goes with this attitude, discourages good men and inclines them to resort to just such trickery as has been cited, to satisfy some misguided official.

Another poor policy is to hold firemen to a standard percentage of CO_2 which they must obtain or be discharged. A little better, but also having its disadvantages, is the bonus system. It is a temptation for the men to think of their own gain first, and strive for a record by illegitimate means. In their effort to obtain a high percentage of CO_2 they "jockey" the dampers and fires, which very often results in reduced steam pressure at a critical time, and nearly always means an excessive coal consumption. If bonuses and standards must be used, equip the boilers with recording thermometers and draft gages that will reveal fraudulent manipulation.

A man's job means much to him and he will hold it longer and do better work if not provoked to deception.

In the article on the Baumé hydrometer, page 150 of the July 30 issue, the figures were transposed in the composition given for one of the calibration solutions. The mistake occurred at the bottom of the second column and is very obvious. The solution should have been given as 10 parts of salt to 90 parts of water.

When a marine engineer tells you that "too high a vacuum does not pay," you can make up your mind that there's nothing in it (meaning the vacuum).

Readers with Something to Say

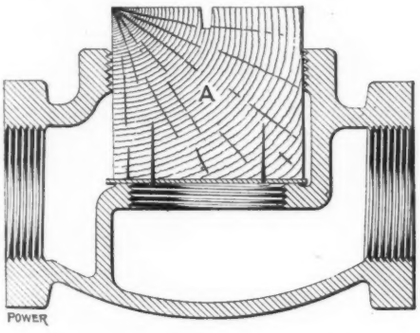
A letter good enough to print will be paid for. Ideas, not mere words, wanted

Simple Valve Reseating Device

For engineers of small plants that do not have a valve-reseating machine, the substitute illustrated will be found satisfactory.

Make a wooden plug *A* that will go loosely through the bonnet opening in the valve and bear squarely on the valve seat. Next, saw a slot in the top of the plug to engage a bit-brace screwdriver. Cut several pieces of emery cloth the size of the plug and tack them on the end of the plug, putting the tacks in the middle. The device is now ready for use.

Put the plug in the valve body and turn it with the brace. When the emery cloth fills with brass, tear it off and another clean surface is exposed. The plug can best be made in a lathe, but one can be



RESEATING BLOCK IN POSITION

made with a knife and hacksaw in a few minutes, that will give a perfectly true and highly polished surface to a valve seat.

F. L. PERKINS.

Waltham, Mass.

Broken Stud Buckles Piston Rod

Our engine, which is located in the basement some distance from the boiler room, commenced to knock, and upon arriving in the engine room, I found steam escaping around the piston rod and a knock at the head end at every revolution. I stopped the engine and examined the marks on the crosshead and guides for clearance, and on the crosshead and rod to see that the rod had not backed out of the crosshead. I found the clearance equal and the rod in place.

After further examining the engine I again started and finished the day at noon as we only run a half day on Saturday. Upon removing the flange and false head, I found the cause of the trouble. One of the studs had broken off in the piston spider and, in working out, had been caught between the piston and head. The clearance being $\frac{1}{16}$ in. and the nut on the stud $1\frac{1}{8}$ in. something had to give which happened to be the rod for it bent in two places, so that the piston was $\frac{1}{4}$ in. out of square with the rod. The follower plate had an imprint of the nut on one side and cracks running in all directions on the other side. The bridge dividing the foot of the head end also cracked through. As the cylinder was considerably out of round, I had it rebored and fitted with a new rod, junk ring, packing rings, centering bolts and a set of studs.

From the appearance of the metal at the break, it had been broken for some time, but, fitting tightly in the hole in the spider, it was prevented from falling immediately. As the stud that failed was the upper one on the side near the port it fell when the piston commenced the next stroke and was out of reach in the port when I found it.

Since being repaired the engine runs very smoothly and considerable less coal is consumed, owing to the tight piston and true cylinder.

A. C. SIDINGER.

Salem, Ohio.

Direction and Amount of Strain on Pins

It is sometimes desirable to show the direction and strain on the two pins that support a lever of the form illustrated. A mathematician can easily give a calculation intelligible to other mathematicians, but the mechanic needs a simpler solution.

Assume the weight to be 100 lb., and it is desired to determine the direction and extent of the strain on the pin *B*. The weight is trying to rotate the lever around the pin *A*, and is prevented from so doing by the pin *B*. The strain on *B* is in a direction at right angles to the line *AB* and is as much more than 100 lb. as the horizontal line *C* is longer than the line *AB*. That is, assume those two lines were the arms of a bent lever, the direction of the strain and its extent would be self-evident.

To determine the direction and extent of the strain on the pin *A*, assume that the weight is tending to rotate the lever around the pin *B*. The direction of the strain on *A* must be at right angles to the line *AB* at *D*, and the amount of strain must be as much greater than 100 lb. as the line *E* is longer than the line *AB*.

Why the strain is as the length of the line *E*, instead of the line *BF*, is because the pull of the weight is evidently straight down and at an angle with the line *BF*. If it was pulling at right angles, that is,

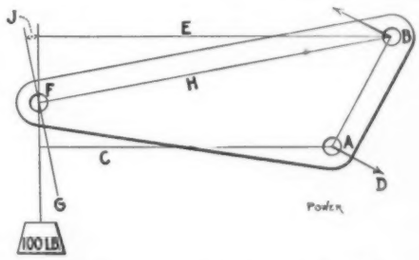


DIAGRAM TO SHOW STRAIN ON PINS

toward *G*, the lever arm would be the length of the line *H;* but pulling at an angle either less or greater than at right angles, the force exerted grows less and the decrease is shown by the difference between the length of the lever and the line at right angles to the pull, as at *J*.

JOHN E. SWEET.

Syracuse, N. Y.

Isolated Plant Management

Owners of isolated plants very often are misinformed by central-station agents, who tell them it is cheaper and more reliable to buy current than to produce it in their own plants. In some plants, where little power is generated, it might be cheaper to buy current, but how about steam heat in the winter? And do not the engineer's services count for something? Who is the first man called upon when things go wrong in a building? How about alterations in the wiring, plumbing and general repairs? In most plants it is "up to" the engineers.

I have encountered this central-station solicitation and had to show my employers that I was making good; otherwise I might now be looking for a job. I have charge of an amusement building and park combined. The capacity of the plant is about 200 kw. The current is used for about five months in the year, and the cost is below 2c. per kw.-hr. The other seven months the load is about 100 kw. The building is heated by exhaust steam only, at $1\frac{1}{2}$ lb. back pressure. The heating surface is 8000 sq.ft. and the

circulation is excellent, there being no trouble in heating the building adequately in zero weather.

The plant consists of two Corliss engines directly connected to two 100-kw. direct-current generators, two water-tube boilers, rated at 150 hp., one vertical slide-valve engine directly connected to a 3-kw. generator, one 16-ton ice machine connected to a Corliss engine, one brine pump 6 and 5¼x6 in. and three 6 and 4 by 6-in. boiler-feed and condenser pumps. I erected the plant personally, and being induced by the management to stay after it was completed, have now had charge about five years.

The manager has received numerous calls from the central-station agents, who talk cheap kilowatt-hours, low-pressure boilers, no-licensed engineers, the porters being able to heat and care for the building, etc. It seemed to him a profitable proposition, so he obtained estimates from the central-station people. The amount which was asked for just lighting our building now pays for heating, lighting and refrigerating; besides my services and the fireman's thrown in.

To win the respect and confidence of our employers we must be absolutely "on the level," save a dollar when we can, stop crying for unnecessary help, and get out of the chair and do some of the work ourselves. Should there be room for improvement which would save dollars, we should not fail to convince them of it.

For instance, our building is used for amusement purposes only. Very often as many as 5000 people congregate; therefore the amount of water used for toilet purposes is very great. Our water bill was at one time $1200 per year. I finally induced my employers to drive our own well at an expense of $350. Our water bill now is just the price of pumping. We use well water for all purposes.

GEORGE ZIMMER.

New York, N. Y.

Engineers' Examination Questions

The following questions were asked an applicant for a first-class license and are given word for word as near as they can be remembered:

1. How much babbitt would you put into a set of crankpin boxes? How would you find out how much you should put in?

2. Tell all the good and bad qualities of both open and closed feed-water heaters.

3. What is the height of a Bulkley condenser? (a) Can it be worked without a pump? (b) Is there any more danger to the cylinder heads with this type of condenser than with others?

4. Where is the weakest part of a Stirling boiler?

5. Suppose that you take charge of a 2000-hp. cross-compound engine, and the superintendent tells you after shutting down the first night that the engine is out of line and he wants it lined up that night and ready to run the next morning and you are not to strip the engine, how would you do it?

6. What kind of metal are pistons made of? What kind of metal are piston rings made of?

7. If you ordered rings and they came too large, how would you fit them so that you would not have to make more than one cut?

8. What have you got to keep the water from going over into the engine if an open heater is used?

9. If the head of a firm should ask you the necessity of an open drip between the cylinder and the open heater, how would you explain that waste of steam to him?

10. How can you balance the load between the cylinder of a cross-compound engine without using an indicator?

The following questions were asked an applicant for a second-class license:

1. Would 1-in. plate be all right to use for a high-pressure boiler? Give reasons for answer.

2. What are the usual sizes of boiler heads?

3. How many rows of rivets are there on the girth seam of a boiler?

4. Why not more?

5. A safety valve set to blow at 100 lb. blows back to 90 lb. How can you remedy it?

6. What is the latest cutoff possible on a single-eccentric Corliss engine? Why not later?

7. How do you get a later cutoff with a double-eccentric engine?

8. On a compound engine, why are two eccentrics used on the exhaust instead of one? Why would not one do for both cylinders?

9. On a duplex pump the piston on one side hits the head. How do you remedy it?

10. If you open the throttle on a single pump that makes one stroke toward the head and stops there, what is wrong?

11. Why will not a compound engine work with the governor working just the high-pressure side alone?

12. When running a condensing plant the vacuum drops suddenly to 10 in. and from that point keeps uniform. What is wrong and how remedied? How would you favor the engine until you got the vacuum back again?

13. Will a slide-valve engine cutoff at ¼ stroke?

14. How do you find the safe working pressure on a boiler?

L. W. CHADWICK.

Bridgewater, Mass.

International Standard for Flanged Fittings

Now that the main objection to changing the present standard of flanged fittings (the cost of new patterns) has been eliminated by the adoption of a new schedule by the manufacturers, it would seem fitting that the representatives of the manufacturers and buyers join forces and agree on one schedule acceptable to both.

The present condition appears to be the result of injured feeling on the part of the manufacturers, who say to the consumer, "You didn't consult us when you made your schedule so we won't use it, but will get up one of our own." As the purchaser usually is in a position to do the dictating, it hardly behooves the manufacturers to maintain too lofty an independence; still it is no more than right that they should have a voice in the schedule to be adopted.

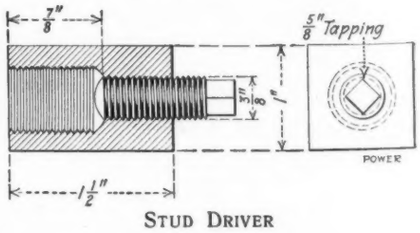
Now that there is to be a new standard, would it not be desirable if England could be included and an international standard drawn up that would be used throughout both countries? Take, for instance, the large amount of engineering work now being done in Canada. In almost all cases part of the material and machinery is purchasd in England and part in the United States. If the same standard were used much trouble would be avoided.

W. S. DURAND.

Brooklyn, N. Y.

A Handy Stud Driver

In setting in studs common practice is to put two nuts on the stud and screw them until they are well locked together. This frequently injures the thread, but it can be avoided by making a stud driver similar to the one shown. For a ⅝-in. stud a piece of 1-in. square iron is suitable. This is drilled and tapped out ¼ in. deeper than the diameter of the stud.



STUD DRIVER

A ⅜-in. hole is drilled and tapped through from the top also. This small hole allows a pin to be screwed through and comes down on top of the stud, and thus prevents injury to any threads on the stud when screwing it in.

J. A. CAMPBELL.

Providence, R. I.

Locomotives using superheated steam run 30,000 miles with air-furnace iron piston rings; 1000 miles with gray iron rings is considered good.

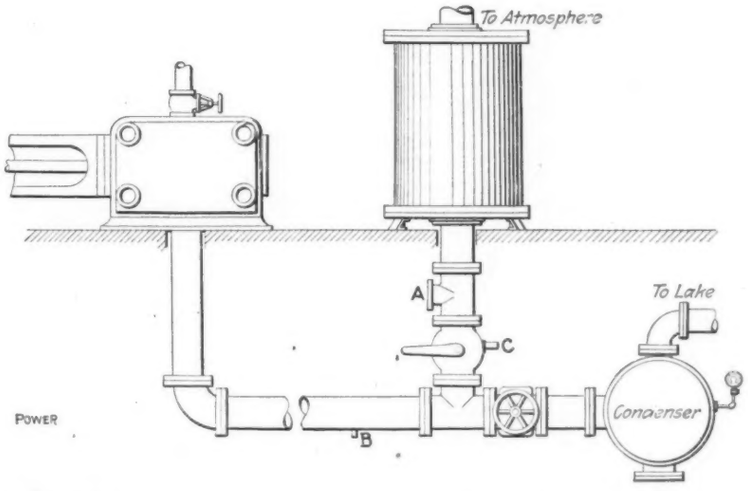
Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Mr. Jacobs' Condenser

If B. A. Jacobs, who writes of condenser troubles in the Apr. 30 issue, will examine the pipe connections from the engine to the condenser and from the condenser to the lake, he will probably find numerous small air leaks, or if the piping is of cast iron, even a cracked piece of pipe. The best way to find the leaks would be to put a water pressure of from 15 or 20 lb. on the system from the engine to the foot valve on the suction pipe. If he cannot get the condenser to maintain a vacuum of at least 26 in., when the engine is fully loaded, he will have to decrease the suction lift to 18 or 20 ft. as suggested by C. E. Aldrich in the June 18 issue.

I believe that the plan of piping, shown herewith, has several advantages over Mr. Aldrich's. It would be less work to make the change and the chances for air leakage are fewer. By reducing the number of right-angle turns by four, and doing away with about 20 ft. of pipe, the vacuum would be increased, 1 or even 2 in.



PROPOSED ADDITIONAL CHANGES IN MR. JACOBS' CONDENSER LAYOUT

By using the exhaust steam from the boiler feed, condenser and air pumps in the heater, as shown by the connection at *A*, the temperature of the feed water would be increased 60 deg. or more. If for any reason the pump must be stopped and the engine run noncondensing, its exhaust would then pass through the heater, still maintaining a higher feed-water temperature.

An automatic atmospheric valve should be installed to prevent serious accident. A drip and vacuum breaker should be provided, as shown at *B*, and also a drip about 2 or 3 in. above the seat of the atmospheric valve, as shown at *C*. This would serve the double purpose of keeping the exhaust pipe from the atmospheric valve to the heater free from the condensation from the pump exhaust and also serve to form a water seal on the top of the atmospheric valve.

W. A. FIELD.

Anoka, Minn.

Crank Position on Shafts

In the June 4 issue, C. E. Aldrich writes as to the positions of the cranks of a three-cylinder plunger pump. In the construction of the engine the unusual water end (as he describes it), and the movement of the plungers is the main factor to be considered. As each set of plungers is driven directly from the crossheads it would be necessary to have the cranks placed at 120 deg., to have the plungers advanced the same distance apart to effect a continuous flow of water. Another point to be considered is the operation of the valves. With the cranks at 120 deg. the valves will operate at regular intervals, which is necessary for a smooth running pump.

If the cranks were placed at any other position than 120 deg., the plungers would be unequally spaced. thus causing an unequal and irregular flow of water and other undesirable results which would have to be overcome by additional appliances.

C. E. FLETCHER.

Hanford, Calif.

Submerged Flotation

The discussion of "Submerged Flotation" in the issues of June 4 and July 9 brings to mind an inquiry the writer often heard soon after the disaster to the "Titanic," "Why don't they raise her?" When the practical difficulties are made clear, such questions have arisen as, "What is there left to raise?", all based more or less upon the question, "How hard did she hit bottom?"

So many things are involved that an estimate can only be approximate. Starting with the vessel's weight acting against the water resistance, exact calculation is complicated by its submerged weight varying with depth. Neglecting this let us use weight as the propelling force downward, and, consider a straightforward plunge. At high velocities, when a partial vacuum would be formed behind the vessel (similar to the vacuum formed by test propellers revolving at enormous speeds and low efficiencies), although the formulas for marine resistance may not be expected to hold with entire reliability, the approximation will be of interest. Considering the cross-sectional area, or the resistance of the entire vessel, to be, say three times that of the hull below the water line, we must triple the resistance per ton of weight which is indicated by the formula.

The various formulas for the resistance of water to vessels passing through it, all depend upon the exact shape, size and proportion of hull. A common approximation of this sort is

$$R = \sqrt[3]{D^2} \times V^2 \times C$$

where

R = Resistance;
D = Displacement;
V = Speed;
c = Constant depending upon the lines of the vessel.

Another method, which amounts to the same thing but has an actual rather than a theoretical basis, is to take the horsepower required to propel some large vessel at a given speed, reduce it to the corresponding propeller thrust (or pull in a tow line) and calculate the force necessary to drive the vessel at other speeds, from the well known laws of variation in

horsepower, or in resistance with speed. This variation in horsepower is approximately as the cube of the speed, or, the variation in resistance is as the square of the speed.

For ready reference, we will use a figure from Kent, where, under "Results of Progressive Speed Trials in Typical Vessels," we find the indicated horsepower of a steamship of 11,550 tons displacement given as 14,500. Assuming a combined engine and propeller efficiency of 65 per cent., the corresponding actual propelling horsepower becomes 9425. Dividing this by the tonnage, we have 0.81 hp. per ton, or $33{,}000 \times 0.81 = 26{,}730$ ft.-lb. per min. A knot or nautical mile being 6080 ft., 20 knots per hour is 121,600 ft. per hour, or 2026 ft. per min. Then 26,730 ft.-lb. through 2026 ft. corresponds to $26{,}730 \div 2026$, or 13.2 lb. pull per ton at 20 knots per hour.

At 40 knots per hour, since the square of 40 is four times the square of 20, the force required will be four times the force required for 20 knots per hour, or 52.8 lb. Similarly, at 80 knots the force is $52.8 \times 4 = 211.2$ lb., and at 160 knots, 844 lb. This is based upon submergence of only that part of the hull below the water line. Since we are to triple the resistance because of the entire hull and upper works being submerged, we have 3×844 or 2532 lb.

The marine ton in the air weigh 2240 lb., but when submerged steel is considered weighs around 1960 lb., or, say 1500 lb. The vessel with its contents is not all steel, but contains porous material thoroughly saturated under enormous pressure.

Starting with 20 knots per hour, and a resistance of 13.2 lb. pull, for any other speed V the resistance R is found by the formula

$$\frac{V^2}{20^2} = \frac{R}{13.2}$$

or

$$R = \frac{13.2\ V^2}{20^2} = 0.033\ V^2$$

for regular propulsion, or with three times the resistance per ton when entirely submerged,

$R = 0.099\ V^2$, or $0.1\ V^2$ (approximately)

Using our estimate of the weight of a submerged ton of vessel, $R = 1500$ lb., $1500 = 0.1\ V^2$, or $V^2 = 15{,}000$, or $V = 123$ knots per hour, approximately, the combined speed of two passenger trains meeting at 65 miles per hour, or 208 ft. per sec., $\frac{1}{10}$ the velocity of the projectile from a high-power rifle, or the theoretical velocity of a body which has fallen from a height of 700 ft.

Did the "Titanic" have this velocity when she struck the bottom? Because of the variables involved, especially the variation in specific gravity with depth, any attempt to calculate the acceleration in water, due to gravity, would involve considerable guess work. Our figures are of interest merely as indicating the velocity which may have been obtained, and which probably was not exceeded.

E. G. MEDART.

Quincy, Ill.

[The calculation is interesting, but the premises and conclusion exceedingly doubtful.—EDITOR.]

The College Graduate and Practical Experience

The scheme suggested by Julius G. Berger, under the above heading in the June 25 number, would work if it could be carried out successfully. Will Mr. Berger please name some factories where a man can get such a training and at the same time be earning a little coin. To most men who are working and who expect work in power plants, "earning as you learn" is often necessary. Most of them are not rich and cannot afford to pay a premium to a firm to teach them.

Mr. Berger mentions the General Electric Co. as a sample of industrial concern to learn with; perhaps he is right, but will it work out in practice? Has he had the practical experience or is he just giving us theory? I worked for some years with the Canadian General Electric, and also in some other large industrial concerns, and I have learned some things.

A man might get employment, but he could put in a lifetime with any one of them, and fail to get a chance to learn very much of value about the different apparatus in use, because he will not be allowed to work at what he wishes, but will have to work at what the foreman puts him on. In large industrial factories, the rule is generally to place a man at some particular machine or in some department and keep him there, the man may become an expert in that one branch, but he will get little chance to get practical instruction or experience about anything else. If he can afford to pay the company a premium and work for "nothing in the pay envelope," they may take him as a student, and if he is a pusher he can learn, but even in this case he may have to fight for his rights, for in some cases an endeavor will be made to keep him at certain things as long as possible so that the firm may make something from his work.

In one factory where I was employed, the student system was in force and little or no endeavor was made to teach them what they were paying for, with the result that two-thirds of the students' time was spent in loitering—time which was being paid for in most cases, at a good stiff figure—by the parents of the students. Even a young man who enters such a factory determined to learn, will lose interest and become indifferent, when he sees that the ones being paid to look after his education are indifferent to his success or failure.

About the only way a man could get such an education as Mr. Berger suggests would be to work with one firm in some department for a short time, then if he could not get transferred to another, he should leave and try to get what he wants with another firm and so on if necessary. Even using this scheme he might have to work for very small wages as his services would be of little or no use to these firms at the beginning of his work.

If he can get employment in a good power plant and will use his spare time in study, making a change to different plants when opportunity offers, he will ultimately become as good a man as the best and would understand human nature just as well as in the former case.

JOHN THORN.

London Junction, Ont.

All Mr. Berger says is true; and I agree with him fully,, but he looks only on one side of the question. How about the college student who has to work to pay his way through college? Can he afford to spend two years more as an apprentice in some large manufacturing establishment?

In the first place, the pay these large concerns offer apprentices is just about enough for them to live upon if careful not to indulge in pleasures of any kind, and after four years of hard work at college without any pecuniary reward, it is hard for the student to go back to it for two years more. He wants to be independent, and enjoy life. Besides, he may have had to borrow money to help pay his way through college, and he is anxious to repay it.

To my mind the right thing is for the graduate to pick out his field of work, and get a job in that field. His first job may be at the lowest rung of the ladder; but any student who has had to work his way through college will not be afraid to tackle almost any sort of a job. The next thing is to stick to his job; if he shows the right spirit he will soon be rewarded with a better position and better pay. At the end of two years he will be better off, perhaps, than his classmate who worked as an apprentice for some large manufacturing concern. The former will be holding a position with some responsibility attached to it, while the latter will yet have to make up his mind as to what branch of engineering he will follow, and go out and get a job.

A technical education only opens the various engineering fields to the student and gives him a good foundation for deeper study in any particular field. While at college a student should make up his mind to what field he will devote himself. If he has had to work his way through college he is more likely to get

much more out of his course than if he is fortunate—or, I should say, unfortunate—enough, to have everything he needs without knowing the value of a dollar, and having all his own time taken up with pleasures. This student needs at least two years of apprentice work to make him wake up and realize that earning one's own living is a serious thing.

J. E. POCHÉ.

New Orleans, La.

Failure of Boiler Tubes

The July 9 issue contains a letter on this subject by W. A. Cooil, which is a comment on Mr. Maxwell's complaint in the issue of May 28.

Mr. Cooil's solution is correct, so far as it goes, but he does not explain the real cause, which can be nothing but the scale deposit on the tube. A perfectly clean tube submerged in water or filled with water cannot possibly become overheated, no matter how intense the heat is in or around the tube. If the tube is clean the water readily absorbs the heat, and the tube temperature cannot exceed that of the water itself, but if the tube is coated with a thin film of scale or even of oil, the tube temperature may be raised far above that of the water.

At 500 deg. the tensile strength of an average boiler tube is about 66,000 lb. At 1200 deg. it drops to about 10,000 lb. Under such conditions it is not surprising that tubes sometimes fail.

When the tube becomes overheated it naturally stretches or expands. If that expansion is gradual and uniform the ordinary boiler is so constructed as to take care of it. In a water-tube boiler, when the tubes expand, the bending is always upward; in a return-tubular boiler, the bending is always downward. This is due to the location of the scale in or on the tube. In a water-tube boiler the scale usually forms on the inside and bottom of the tube. The scale does not expand or contract and holds that part of the tube in a vise-like grip. It is therefore the upper portion of the tube which expands, and as the expansion follows the lines of least resistance, the tube bends upward. For the same reason the tubes in a return-tubular boiler either bend downward or loosen at the header. In 99 cases out of 100 a loose or buckled tube is proof positive of overheating and scale.

Mr. Maxwell states that tubes sometimes bag when perfectly clean, or when the amount of scale is so small that it alone is not the direct cause of the rupture. He little appreciates how small an amount of scale causes overheating and rupture of the tube, and if he investigates he will find the only possible cause is the scale or incrustation deposited on or in the tube. Boiler tubes should last as long as the boiler shell. If clean they are subjected to no extraordinary wear or tear or no unusual strain. It is the strains which destroy the life of the tube and their principal cause is overheating due to scale deposit. This is well illustrated in the arch tubes now being used on locomotives. These tubes hold up the brick arches and, where they are not kept clean, the weight of the arches quickly cause them to sag. When the latter condition prevails, the life of the tube is only two or three months.

C. S. DAVIS.

Buffalo, N. Y.

[If the circulation is poor, a clean tube may bag with an exceedingly hot fire. The water would not be supplied to the tube fast enough to avoid the formation of steam pockets or bubbles, which would allow the tube to become hot enough to bag under pressure.—EDITOR.]

Things Commonly Wrong

The advice in your foreword, "To the College Graduate," May 28, was timely and to the point, especially for the man who expects later to design machinery. He will find valves made with a yoke and if it becomes necessary to pack them he will find that the stuffing-box gland will barely clear the box; if the valve is in a hot place he will wish that the designer had made the yoke ½ in. higher so that the gland would slip far enough back for him to get the packing in handily.

He will find pumps that have threaded stuffing-box glands and if he fills the box with packing, just even full, the gland will not start on the thread. He will find the same trouble on the stud bolt kind where, if the studs were made ½ in. longer and the threaded gland ½ in. deeper, the box could be filled even full and the gland put on without trouble.

He will also find large pumps with the top cover so close to the valve decks that if you happen to break a valve stem off in the hole, he will either have to make a special ratchet to drill it out or break joints on piping and lift the top off. He will also find 3x4-in. handholes for a 4x8-in. hand, then he will wish the designer had made a little more room by having the top a couple of inches higher and the handholes a little larger, as anyone who has worked with pumps will agree. He will find engine beds where the holes come so close to the frame that the jaw of a wrench cannot be got around the nut of the anchor bolt and have the wrench strong enough to turn and tighten the anchor bolts properly.

This same fault is found in all kinds of machinery; I suppose it is done to save iron. On a pump in my plant we had to chip away the casting to get the nuts to turn, and they are hexagon nuts at that.

He will also find valves with bonnets threaded, that have the squared part so narrow that it is almost impossible to make a monkey wrench hold on them, and recourse is had to a Stillson pipe wrench. If he does not put the new valve in the vise to remove the bonnet and replace it with graphite on the threads and shoulder, he will probably not be able to remove it at all, should he put it on the pipe line without the above precaution. I could go on and give other instances, but I think these are enough so that, if the graduate goes to designing after he gets some practical knowledge, as pointed out by you, and happens to see this article, he will give us a little more metal and a little more room where it is most needed.

ISAAC VIGGERS.

Everett, Wash.

Hoarding Knowledge Hinders Progress

In POWER, June 11, the foreword "Hoarding Knowledge Hinders Progress" seems to advise engineers to tell all they know.

No one believes in or enjoys telling or helping any, especially brother engineers, better than I. But let us look at it in a business way. Our technical schools, mechanical or electrical engineers, experts or our trade papers do not give us knowledge free. If we get into any trouble and have to ask expert help, we pay for it.

Then why should we, who have subscribed for many of their expensive books and papers, perhaps taken a course in a correspondence school, exert ourselves to benefit those who will neither buy books nor papers nor help themselves.

We all know men very different from the one pictured in the foreword with a locked safe of knowledge on his head, having instead an exceedingly large and empty cracker box and depending on others to fill it.

Many employers will advise our envesting in books, papers and schools to increase our knowledge, but when we have done so are not so quick to increase our wages. The manufacturer or the agent does not share information with his competitor, but uses it for his own interests and keeps the other fellow guessing. It is his business.

I always like and do help the other fellow and enjoy so doing, but think it is often misused. I believe in education; the more the better, and helping one another and bettering our profession, but it is a matter of honest competition with us as in other lines of business. Nor should we depend too much on the other fellow or his advice. Always help those who will and do help themselves, but if you do not care for "number one," who will?

ASA P. HYDE.

Binghamton, N. Y.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Lubricator Troubles

A standard type of lubricator on the low-pressure cylinder of a compound engine, which has its steam connection taken from the high-pressure end of the receiver, stops feeding a few minutes after the engine is started. What may be the cause and remedy?

W. T. H.

Probably the connection to the receiver is so made that steam sweeps past the lubricator connection and reduces the pressure at the connection below the receiver pressure. This could be remedied by connecting to a bent pipe placed within the receiver with its opening presented to the direction of flow. An easier and surer way of getting sufficient pressure is to lead the lubricator steam connection from the high-pressure steam pipe in place of from the present receiver connection.

Flash Points of Cylinder Oils

What are the usual working flash points for cylinder lubricating oils used for air compressors, steam engines, turbines, gas engines and oil engines?

J. E. M.

For cylinders of air compressors it is desirable to use oils having a flash point of 550 to 600 deg. F. Cylinder oil for use with superheated steam may have a flash point of over 600 deg. F. For steam cylinders with ordinary steam, about 550 deg. F. No oil is used in the steam space of a turbine. For internal-combustion engines, cylinder oil having a flash point of about 450 deg. F. is used, as the heavier oil is likely to leave a residue which will cause back-firing and other troubles.

Submergence of Air Lift in Pumping Deep Wells

For raising water from a deep well with an air lift, where the free surface of water outside of the water pipe stands 210 ft. below the level of the point of discharge, what should be the depth of submergence of the air and water pipes?

J. M. C.

It is found that the highest efficiency is obtained when the air and water pipes extend below the free surface of the water a distance equal to two-thirds of the difference of levels of the free surface of water outside the discharge pipe while lifting, and the point of discharge. The difference of levels being 210 ft., then for best efficiency the submergence should be 140 ft.

Location of Engine Belt Tightener

Should a belt tightener be used on an engine pulley or on the jackshaft receiving pulley?

A. L. J.

Whenever a belt tightener is required it can be used with best advantage to the belt if employed for holding the slack side of the belt to the face of the pulley on which there is the greater amount of slippage. This ordinarily occurs on the face of the smaller pulley and, on that account, tighteners for engine belts are usually employed to greater advantage for holding belts to receiving pulleys, though a tightener should not be on an engine pulley if it is avoidable, as it tends to throw the engine shaft out of line in a direction which is different for each adjustment of the tightener.

Water Horsepower of Pump

What is meant by the "water horsepower" of a centrifugal pump, and what would be the water horsepower and the efficiency of a centrifugal pump having a capacity of pumping 5000 gal. per min. against a total head of 140 ft.?

B. J. T.

The water horsepower would be the number of horsepower which would be developed theoretically by the same quantity of water falling per minute from the same height. The 5000 gal. per min. raised against 140 ft. head would absorb energy at the same rate that energy would be generated by the fall of the same quantity of water from the same height in the same time. Taking the weight of 1 gal. of water at 8⅓ lb., the work performed in either instance would be at the rate of $5000 \times 8\frac{1}{3} \times 140 = 5{,}833{,}333$ ft.-lb. per min. or

$$\frac{5{,}833{,}333+}{33{,}000} = 176.76$$

water horsepower.

The efficiency would be the ratio of the water horsepower output to the brake horsepower input at the coupling or pulley which receives the power required for driving the centrifugal pump. The efficiencies of well designed centrifugal pumps of the capacity stated, range from 75 down to 70 per cent. The net or brake horsepower required therefore would be from $\frac{176.76}{0.75}$ hp. to $\frac{176.76}{0.70}$ hp., or from about 236 to 253 hp.

What is an Interpole Motor?

What is an interpole motor?

R. C. D.

One which has small poles located between the main poles, their windings being in series with the main circuit. The magnetizing effect of these poles counteracts that of the armature reaction; hence shifting of the neutral plane is prevented, and the brushes need not be shifted when change of load occurs.

Efficiency of Double Riveted Lap Joint

What would be the efficiency of a longitudinal double-riveted lap joint of a boiler made of ⅜-in. plate of 55,000 lb. tensile strength and 2¾-in. pitch of ⅞-in. rivets having a shearing strength of 42,000 lb. per sq.in.?

C. P.

The cross-sectional area of the solid plate for the pitch distance, 2¾ in., would be

$$2.75 \times 0.375 = 1.03125 \text{ sq.in.}$$

and the strength would be

$$1.03125 \times 55{,}000 = 56{,}718.75 \text{ lb.}$$

As the distance between the rivet holes would be

$$2\tfrac{3}{4} - \tfrac{7}{8} = 1.9375 \text{ in.}$$

the cross-sectional area of plate between rivet holes would be

$$1.9375 \times 0.375 = 0.72656 \text{ sq.in.}$$

and the strength between rivet holes would be

$$0.72656 \times 55{,}000 = 39{,}960.8 \text{ lb.}$$

For each pitch distance, there would be the resistance of two rivets in single shear. The diameter of rivets being ⅞ in., the area of each rivet would be 0.518487 sq.in. and the strength of rivets would be $0.518487 \times 2 \times 42{,}000 = 43{,}552.+$ lb.

The strength of a joint of the dimensions given would therefore depend on the strength of metal between the rivet holes, and the efficiency would be,

$$\frac{39{,}960.8}{56{,}718.75} = 0.7045$$

of the strength of the solid plate, or 70.45 per cent.

Study Questions

This Week's Questions
Last Week's Answers

(76) A 1½-in. wrought-iron bolt with a head ¾ in. thick is under a tension of 12,000 lb. What is the stress per square inch tending to shear the head off?

(77) An eliptical manhole has a major axis of 24 in. and a minor axis of 16 in. What is the area of the opening?

(78) A man wishing to gage the height of a stack holds a 1-ft. rule vertically in front of him so that the top of the rule is in line from his eye with the top of the stack and the bottom of the rule in line with the bottom of the stack. He then finds the horizontal distance of the rule from his eye to be 18 in. and his own distance from the base of the stack 162 ft. How high is the stack?

(79) Given that steam at 15 lb. pressure occupies a volume 1670 times that of the same weight of water, how many pounds of water must be evaporated to fill a cylinder 74 in. in diameter by 7½ ft. stroke with steam at 15 lb. pressure?

(80) How much more heat is realized in burning a pound of carbon to carbon dioxide (CO_2) than in burning it to carbon monoxide (CO)?

Answers to the above will appear in the next issue. Answers to last week's questions follow:

(71) This problem illustrates the use of the barrel calorimeter.

Let x = Quality of the steam.

Neglecting radiation and the effect of the barrel in absorbing heat, the heat taken up by the water must exactly equal that given up by the steam. The heat taken up by the water is its initial weight 360 lb. multiplied by the rise in temperature (109.6 — 52.8 = 56.8 deg.) or

$$360 \times 56.8 = 20{,}448 \text{ } B.t.u.$$

The heat given up by each pound of steam condensed is equal to its quality x times the latent heat of evaporation (891.3 B.t.u. for steam at 79.7 lb. gage) plus the difference between its temperature (323.3 deg. F.) and the final temperature of the water (109.6); that is,

$$x \cdot 891.3 + (323.3 - 109.6) = x \cdot 891.3 + 213.7$$

The total heat given up by the steam is this quantity multiplied by its weight (final weight of water minus initial weight, or 379.1 — 360 = 19.1); that is,

$$19.1\ (x\ 891.3 + 213.7) = 17{,}023.83\ x + 4081.67$$

Equating the heat given up by the steam to that taken up by the water

$$17{,}023.83\ x + 4081.67 = 20{,}448 \text{ } B.t.u.$$

$$x = \frac{20448 - 4081.67}{17023.83} = 0.9613$$

or

= 96.13 per cent. quality.

Therefore, the percentage of moisture is

100 — 96.13 = 3.87 *per cent.*

(72) From

$$Area = \frac{\pi D^2}{4} = 0.7854\ D^2$$

the area of the high-pressure cylinder is 615.75 sq.in.; of the intermediate 2123.72 sq.in.; of the high 4071.51.

Multiplying the area of each cylinder by the mean effective pressure in that cylinder and adding the three gives

$$\begin{array}{r} 60 \times 615.75 = 36{,}945 \text{ lb.} \\ 38 \times 2123.72 = 80{,}701.36 \text{ lb.} \\ 18 \times 4071.51 = 73{,}287.18 \text{ lb.} \\ \hline 190{,}933.54 \text{ lb.} \end{array}$$

as the total pressure.

Multiplying this by the length of stroke in feet and by twice the rotative speed and dividing by 33,000 gives

$$\frac{190{,}933.54 \times 4.5 \times 2 \times 100}{33{,}000} = 5{,}207.28\ i.hp.$$

(73) With a factor of safety of 4½ and an ultimate shearing strength of 40,000 lb. per sq.in., the safe working stress will be

$$\frac{40{,}000}{4.5} = 8888.88\ lb.\ per\ sq.in.$$

There will then be required

$$\frac{20{,}000}{8888.88} = 2.25\ sq.in.$$

of area in the rivets and as each ⅞-in. rivet has a cross-sectional area of 0.60132 sq.in.

$$\frac{2.25}{0.60132} = 3.74\ rivets$$

making four rivets the smallest allowable number to be used.

(74) All data must be reduced to the foot-pound-second system. If the body had covered 315 yd. in 179 sec., its initial velocity was

$$c = \frac{315\ yd. \times 3\ ft.}{179\ sec.} = 5.279\ ft.\ per\ sec.$$

Its final velocity when covering 10,800 in. in 1/50 hr. was

$$v = \frac{\frac{10{,}800\ in.}{12\ in.}}{1/50\ hr. \times 60\ min. \times 60\ sec.} = 12.5\ ft.\ per\ sec.$$

The time the force acted was

⅔ *min.* × 60 *sec.* = 40 *sec.*

Then from the formula

$$v = c + pt$$

where

v = Final velocity;
c = Initial velocity;
p = Acceleration;
t = Time;

Then

$$12.5 = 5.279 + 40\ p;$$
$$p = 0.1805.$$

The total force acting was

$$P = Mp$$

where

$$M = \text{Mass} = \frac{G}{g}$$

where

G = Weight in lb.;
g = Acceleration of gravity = 32.2;
G = 2½ tons = 5000 lb.

then

$$M = \frac{5000}{32.2} = 155.28\ lb.$$

and

$$P = 155.28 \times 0.1805 = 28.028\ lb.$$

(75) The volume of the room would be

$$40 \times 80 \times 12 = 38{,}400\ cu.ft.$$

To change the air five times an hour would require this quantity of air every 12 min. The fan discharge should be

$$\frac{38{,}400}{12} = 3200\ cu.ft.\ per\ minute.$$

The South's Hydro-Electric Progress

The remarkable progress being made by the South in hydro-electric development is an example to the rest of the country. Plans are being carried forward rapidly for the formation of the Little River Power Co., which will supply energy throughout the northern part of Alabama.

Three water-power developments, having a total rated output of 150,000 hp., are contemplated, the first being on the Little River, near Fort Payne, la., which will have a rating of 50,000 hp. under a head of 590 ft. Energy will be transmitted from the plant at 100,000 volts to Anniston, Gadsden, Huntsville and neighboring localities.

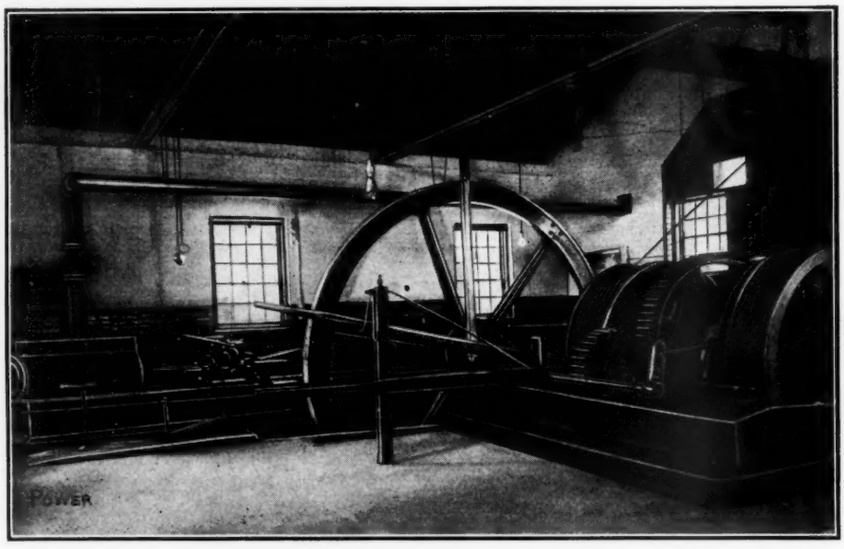
The Dix River Power Co. will build a large hydro-electric plant on the Dix River, near its confluence with the Kentucky River. It expects to spend $3,000,000 on its 24,000-hp. plant, and in constructing transmission lines to Louisville and Lexington, Ky., and Cincinnati, Ohio, as well as to smaller towns nearby, such as Stanford, Harrodsburg, Lancaster, Nicholasville and Danville. A feature will be a 200-ft. concrete dam across the river near Danville.

The formation of the Tennessee Ry., Light & Power Co., with a capital and bonds of $120,000,000, points to a huge hydro-electric development to serve large portions of Tennessee and Georgia. The Tennessee Power Co. will own the 20,000-hp. hydro-electric plant on the Ocoee River at Parksville, Tenn., now in operation; the transmission lines now in use from this plant, by way of Cleveland, to Chattanooga; the transmission line from Cleveland to Knoxville, Tenn., which is nearly completed; the transmission line from Cleveland southward to the Georgia state line; the Great Falls power site and reservoir at the junction of the Caney Fork and Collins rivers, near Rock Island, Tenn., capable of developing 80,000 hp., and two additional sites on the Ocoee River, one capable of developing 16,000 and the other 30,000 hp.

Old Time Hoisting Engine

The new design of hoisting engines so commonly seen about collieries has, in most instances, supplanted the earlier make of engine which was used for hoisting purposes, but a few of the old-timers may still be seen at work on shafts where miners and supplies are handled. These engines were of the single type and were known as "hook" engines, because the eccentric reach rods hooked onto a rocker-arm much as the carrier arm of a Corliss engine hooks onto the wristpin of the wristplate.

The eccentric rods were each operated in and out of gear by a foot lever which was hung on an iron pivot stand at the



OLD HOISTING ENGINE OF THE HOOK VALVE-GEAR TYPE

center and connected with a hooked rod at the inner end; the other end was made with a flat footplate. As the rotation of the engine was reversed, one of the eccentric rods was lifted from the pin of the rocker-arm and secured in that position by a lever which was held in an off or unlocked position when the eccentric rod was not hooked onto the rocker-arm pin.

The rocker-arms hung from a rocker shaft which ran across the crosshead guides and operated the valve stem as the rocker-arm was actuated by the eccentric to which it was connected. If the valve had lead at one end of the cylinder with one eccentric hooked up, the lead would be charged to the other end of the cylinder when the other eccentric was hooked up. The rocker-arm was fitted with a starting-bar. In starting the engine the engineer handled the throttle-valve lever with one hand, the starting-bar with the other and operated the foot lever which controlled the eccentric rod with the foot.

The illustration shows a box-frame engine of this type which is still in operation at the Barnum colliery of the Pennsylvania Coal Co., Pittston, Penn. It has but one 12x24-in. cylinder. No date appeared on it anywhere, but it is supposed to have been built about 1849. The main bearings are adjusted by wedges and keys, the latter being held in place by setscrews.

The engine shaft is fitted with a spur gear which meshes with a large gear on the drum shaft. The engine shaft also supports a 14-ft. flywheel with a 3¼-in. face. The two drums are 7 ft. in diameter and have flat faces.

Naturally the band brakes are of the old type. There are two long wooden brake levers, one of which is loosely secured to the engine shaft by an iron band which passes around the shaft and is bolted to the end of the brake lever at the top and bottom. The brake band is secured to the drum frame on one side and to the top of the brake lever on the top side near the end by an eye-bolt connection. Shoving the lever down tightens the brake band. The second brake lever operates in the same manner, with the exception that it is attached to a cross shaft which tightens the end brake band by a series of link connections. The levers are held up by a hook when the brake bands are loose and by a saw-tooth piece of iron when tight.

The Expert and the Engineer

The engineer sat in his easy chair, puffing an occasional ring from his favorite pipe toward the dirty ceiling as he leaned back and reflected on the possible chances of the various aspirants for local political offices. After about half an hour he made the rounds of the engine room, looked at the steam gage, filled the oil cups and cylinder lubricator, felt of one or two bearings and resumed his chair. These were his duties, varied only by an occasional gasket to be replaced, a pump to pack or a glass to put in; they had been the same for several years.

Employed by a manufacturing concern, his place was in an obscure corner of the building and his existence was called to the attention of the management at times by fuel bills to be paid, also little items for repairs for his department and in addition to some salesmen who asked to see him; moreover, the boiler inspector when he called often referred to him by name. He made out no reports, and kept no log of any description, and as long as he was let alone he was perfectly satisfied except on payday. Being master of his own profession, with nothing more to be attained or learned, he often found time to consider and imagine improvements which might be made in other departments, but always resented any suggestions relative to his own.

Recent increases in machinery had made necessary the installation of a new and larger engine which when purchased was of another make than he had recommended. This engine had never run as it should, in his estimation, and he had broken his silence to the management to report that fact, greatly to their surprise. As a word from him was so unusual, they thought something certainly must be wrong and notified the engine company that the call of one of their experts would be appreciated.

The expert, upon his arrival, was escorted to the engine room by the superintendent and introduced to the engineer, with whom he did not "take" at all. First, because he wore "dude" clothes and even had on kid gloves; second, his manner and speech were what the engineer thought belonged at pink teas or missionary-society meetings. He was very agreeable, polite and precise in his language and the engineer made no secret of his disapproval.

The expert looked over the place; told the engineer he would be on hand early the next morning and bid a friendly good day.

Upon the engineer's arrival the next morning he was surprised to find the expert already on the scene, but somewhat changed in appearance; he now wore overalls and did not seem to feel out of place in them. As the engineer opened the feeds on the oil cups, the expert opened the cylinder drips. This act, the engineer believed, furnished the proper opportunity for letting the expert know his position; he accordingly turned fiercely upon the latter with that purpose in mind, but met a clear, penetrating gaze from a pair of gray eyes which rather changed his mind and caused him to defer the outburst. At the same time the expert remarked that time was valuable when one of the engines was to be out of service, and consequently part of the plant.

After the other engines had been started, the expert proceeded to the business in hand with a despatch which took the engineer by surprise. He asked questions which were to the point and asked them in a way which the engineer could not evade. He asked by name and size for the tools wanted, asked for them all before he began and did not omit any which were needed afterward. As he picked one up he told the engineer what to do with another, and the engineer was mortified to note how much quicker the expert could handle them than he could. It apparently came natural to do what the former told him to do.

After the valve-chest cover had been taken off, the expert inquired who had tried to set the valves since the erecting man left, and whether the engineer owned and used an indicator. The engineer replied that he had changed the valves and did not have an indicator; furthermore, he had never felt the need of one. The expert said he would set the valves again and then use his indicator, which had been brought along. This he did and after the valves had been adjusted the expert smilingly told the engineer that there was nothing wrong with the engine and that the makers would agree to any tests which the purchasers wished, but that he had a few friendly words for the engineer personally if the latter cared to listen.

By this time the engineer had changed his opinion of the expert and had come to regard him as an "engineer," agreeing to listen attentively.

"I will be forced to stay here until 4 p.m. and would like to call your attention to a few things," said the expert. "First, there are a few things which you can have and use which will call to the attention of the people you work for, the fact that you are alive: An indicator, for instance; get one and learn to use it. Then some good reading matter—not printed on pink paper or dealing with ball scores, but something that will help you in your work. Then keep a record of what your plant is doing. I notice the smoke coming from your stack is about as black as the border of the unused surface around the fires. Every blowoff valve on the boilers is wasting coal into the sewer and the traps are doing the same."

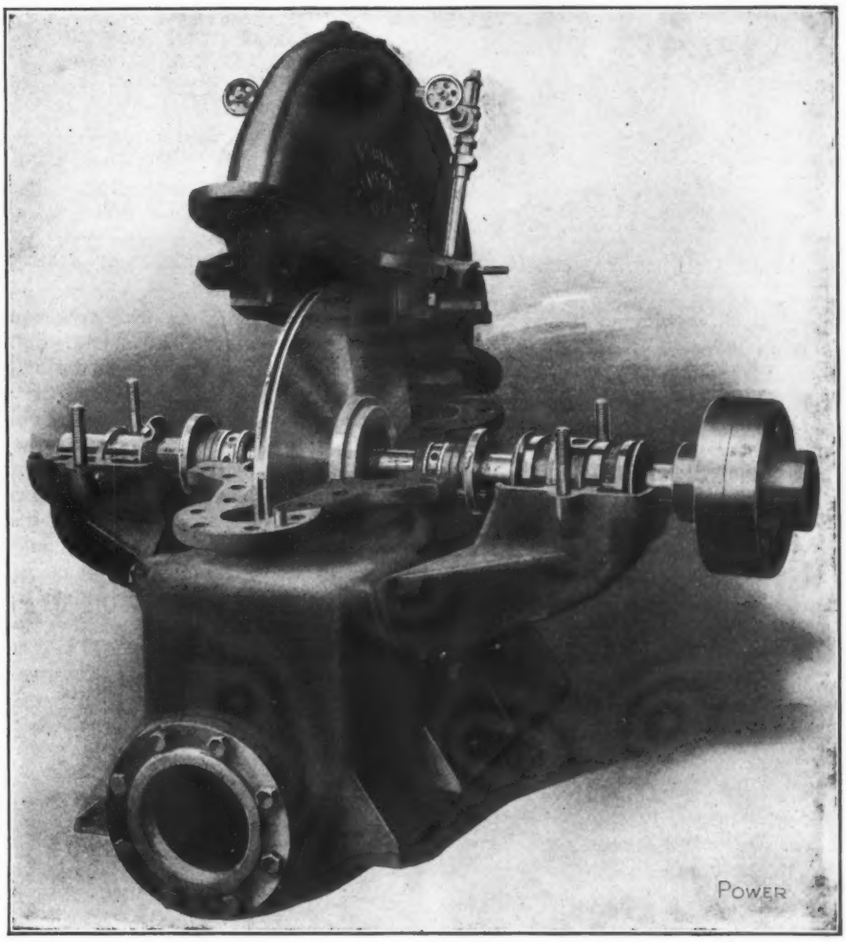
After going over the steam lines into the factory which furnished steam for purposes other than power, and pointing out leaks, the expert got the engineer and his firemen together and described briefly the "A B C" of combustion; then spent the balance of his time instructing the engineer how the proper procedure in getting up cost comparisons and how to figure them.

After he left, the engineer reported that he was thoroughly satisfied with the new engine. Two months later he told his wife of his raise in salary.

Goulds Centrifugal Pump

The illustration herewith shows the general construction of a new single-stage, double-suction centrifugal pump recently developed by the Goulds Manufacturing Co., Seneca Falls, N. Y. This pump is adapted for general water supply, hot-water circulating in heating systems and all services where the total head does not exceed 150 ft.

As shown, the casing of this pump is divided horizontally to give access to the interior of the pump. The two parts are bolted together and doweled to give exact alignment.



DESIGN OF THE GOULDS CENTRIFUGAL PUMP

The machined impeller is of the inclosed, double-suction type, the water being taken in axially from both sides through openings surrounding the shaft. The two streams are directly opposite, thus giving hydraulic balance and preventing end thrust. The impeller and other parts of the pump are such that serious overloading of the driving mechanism is impossible. The shaft stuffing-boxes are provided with water-sealing rings.

When used for pumping liquids which attack iron, the pump is furnished with a bronze impeller and all parts of the shaft coming in contact with the liquid are covered with a bronze sleeve.

Cylinder Lagging and Economy

BY JAMES H. CANNELL

There is a great loss of heat from engine cylinders due to radiation and conduction. This loss must have a considerable effect upon the economy of an engine, and in order to find the improvement in the steam consumption of a triple-expansion high-speed engine, due to a more complete lagging of the cylinders, the following tests were taken.

The engine to be tested was coupled direct to a 330-kw. dynamo and this was the means of loading the engine. Three series of tests were taken, the first with the standard engine, the second with the special cylinder lagging, and the third was a repetition of the first series in order to find if there had been any improvement in the steam consumption due to the prolonged running. If during the tests there had been an improvement in the economy of the engine, due to the piston and valve rings becoming tighter, or to decreased friction of the engine, then this improvement would have to be taken from that due to the more complete lagging.

The arrangement of cylinders and lagging during the first series of tests is

shown in Fig. 1. The engine is of the usual design of this type, the throttle valve being at the side of the high-pressure cylinder and the receivers and exhaust pipes at the back of the cylinders.

The cylinders are quite independent, the only connection between them being the receiver pipes; each cylinder is separately lagged with composition and sheet steel. Owing to the necessity of keeping the centers of the cylinders as close as practicable, the amount of lagging on the sides of the cylinders is reduced to a minimum; the cylinder and valve covers are also lagged, as shown, in the manner usual with this kind of engine.

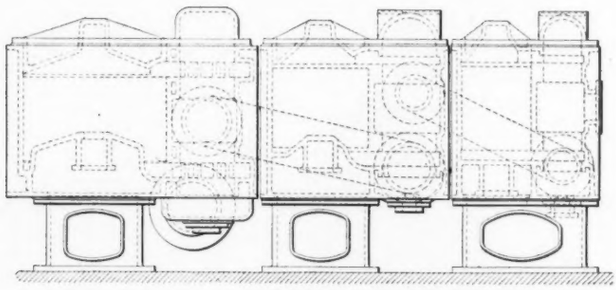


FIG. 1. CYLINDER LAGGING USED DURING FIRST AND THIRD SERIES OF TESTS

Fig. 3 shows the result of this series of tests, the curves of the total steam per hour, and the steam per indicated horsepower per hour being given.

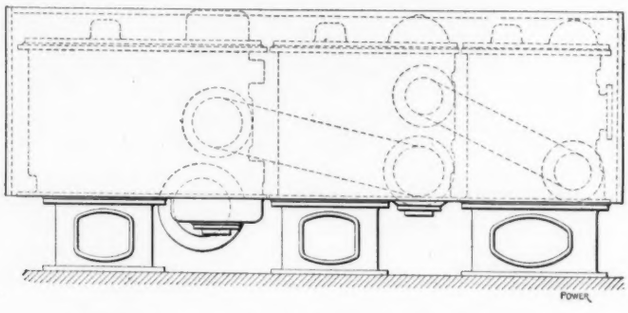


FIG. 2. LAGGING USED DURING SECOND SERIES

By referring to Fig. 1, it will be seen that the flanges of the cylinder and valve covers and part of the top of the cylinder are not lagged, and that there is no air space between the composition and the sheet steel lagging. It is well known that a body of stagnant air is a most efficient lagging, and these tests were taken for the purpose of finding the effect of this and the covered cylinder tops on the economy of the engine.

The lagging during the second series of tests is shown in Fig. 2, in which the sheet steel is continuous around the cylinders and the cylinder tops are covered. In this case there is an adequate air space between the composition on the cylinders and the sheet steel, the steel being fixed on angle irons supported from the cylinder flanges.

The results of these tests are also shown in Fig. 3, in similar manner to the result of the first series of tests, so that the gain due to the more complete lagging is readily seen.

After the second series of tests had been completed the cylinders were again lagged as during the first series, and further tests were taken to find whether any improvement in the economy of the engine, due to the prolonged running, had taken place.

The result of the third series of tests was found to be in close agreement with the result of the first series, proving that the difference between the first and second series was due entirely to the more complete lagging.

By referring to Fig. 3 it will be seen that the percentage of gain due to the improved lagging is practically constant at all loads and that this gain is approximately 6 per cent. From these tests it can be realized how important the efficient lagging of a cylinder is toward attaining the maximum economy from an engine, and this can usually be attained with very little expense.

During the second series the temperature of the air inclosed in the space above the cylinder was taken, and it varied during the various loads from 180 to 200 deg. F. The space between the bottom of the cylinder and the lagging was not inclosed during the tests, but in the subsequent adoption of this type of lagging this was done as it insured a more air-tight lagging.

The curves in Fig. 3 are interesting from another point of view, as they show the usual steam consumption obtained with the best designs of this type of engine. Throughout the tests the speed of the engine was kept constant at 350 r.p.m., the steam pressure at the stop valve was 150 lb. and the vacuum in the exhaust pipe was 25 in.

To obtain reliable results, the steam at the stop valve was superheated from 5 to 10 deg. F. and the steam consumption obtained during the tests was corrected to that which would have been obtained with dry steam, by adding the correction found by previous tests, so that the curves are obtained from tests under the same conditions and can be readily compared.

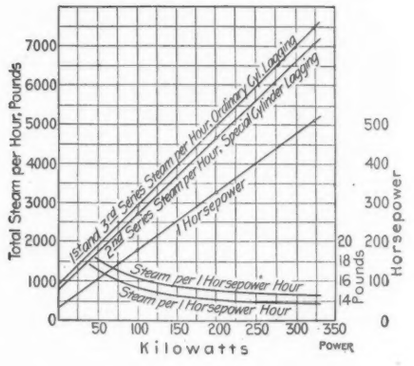


FIG. 3. SHOWING RESULTS OF TESTS

Third International Rubber Conference

During the week beginning Sept. 24, the third International Rubber Conference will be held at the Grand Central Palace, New York City, in connection with the Rubber Exposition. These meetings will be attended by many foreign and American manufacturers of mechanical rubber goods.

The chief topics for discussion will be specifications for steam packings; specifications for steam hose and other hose used by engineers in industrial plants; specifications for textile fabrics used in the manufacture of mechanical rubber goods; efficiency methods in the rubber industry.

Engineers and chemists interested in these topics from the consumer's standpoint are invited to attend the sessions of the conference. Persons desiring to take part in the discussions or present an original paper on a related topic should write to the honorary secretary, Dr. Frederic Dannerth, Third International Rubber Conference, New Grand Central Palace, New York City.

Interesting Diagrams

By M. R. Jonas

In hunting the trouble with one of the engines in our plant, the other day, I obtained some indicator diagrams which may interest some readers.

The engine is a vertical, cross-compound condensing engine having two steam and two exhaust valves on each cylinder. The steam valves are double-slide, one sliding over the other, and the exhaust valves are simple slide. It

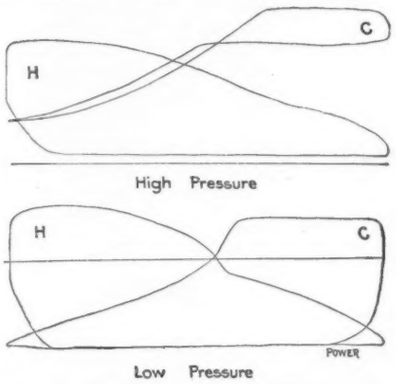


Fig. 1. Effect of Closed Exhaust Valve

is direct-connected to a direct-current generator.

The first indication of trouble was when the engine refused to pull the load, and would only develop half load, and the receiver pressure, normally 20 lb., dropped to 6 lb. per square inch. Upon indicating, the diagrams shown in Fig. 1 were obtained.

Then we saw at once that the trouble was with the crank-end exhaust valve. Upon taking off the exhaust steam-chest covering we found that the nuts holding the valve stem to the yoke had been

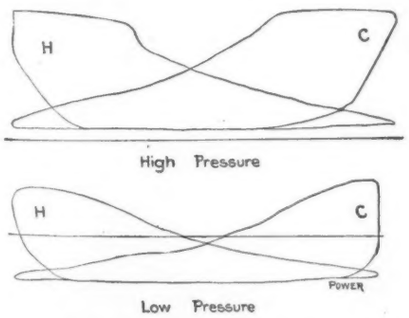


Fig. 2. Showing Normal Operation

stripped off, the stem moving in and out while the valve remained shut. Upon remedying this, the engine pulled full load all right; and the indicator diagrams shown in Fig. 2 were obtained.

The engine exhausts into a condenser together with several rolling-mill engines. A few days each week the mill is down and on these days the engine is run noncondensing. While running under these conditions the indicator diagrams shown in Fig. 3 were taken. It will be seen that the expansion in the low-pressure cylinder goes below atmospheric pressure. Then, when the exhaust valve opens, the pressure increases to a little above atmospheric and stays there during the exhaust. This accounts for the

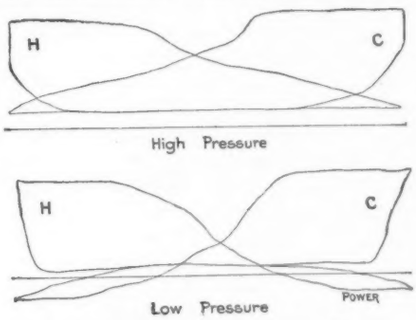
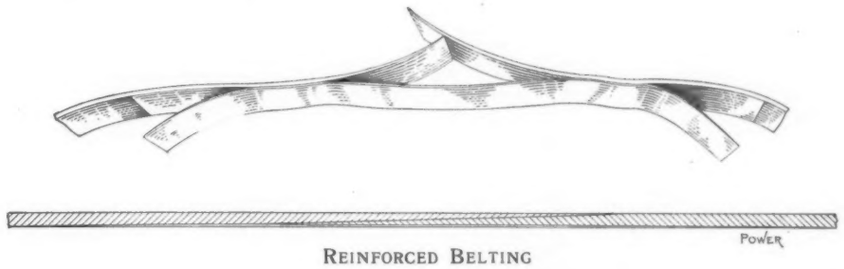


Fig. 3. Showing Conditions When Engine Runs Noncondensing

negative loop and gives a fairly good idea of what a condensing engine will do when run noncondensing.

Reinforced Belting

The accompanying sketches show the method used by the Bronner & Barnewall Co., 111 Hudson St., New York City,



Reinforced Belting

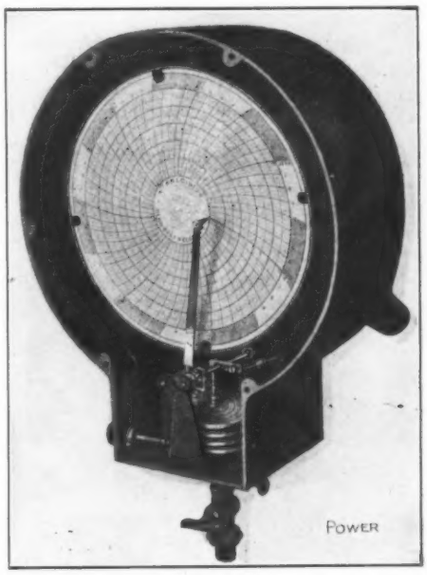
for making the joints of belting. The sections to be joined are skived to a thin edge and reinforced by a strip inserted beneath the joint upon the under side of the belt, as shown. The object is to eliminate uneven stretching, should strips of uneven quality come together in the joint.

Precision Dead Beat Recorder

This instrument, illustrated with the cover plate removed, is manufactured by the Precision Instrument Co., 49 Larned St., Detroit, Mich. The principle and construction of the lever arrangement by which any inequalities of movements of the diaphragm are compensated are shown, making the reading from zero to full stroke.

Variations in pressure or vacuum are transmitted by the diaphragm through a vertical, adjustable plunger attached to a horizontal shaft by an adjustable link. This shaft is supported by a bracket and is normal to the plane of the shaft disk and converts the reciprocating motion of the diaphragm into a rotary motion. When the shaft revolves, the pen-arm moves parallel to the chart, thus recording the pressure.

A screw adjustment projects through the side of the case, by which the operator may bring the pen to zero of the chart. The gage is mounted in either



Dead Beat Recorder

round or standard cases and is suitable for steam, gas, water or other liquids or air. The clock movement used to drive a shaft is an imported jeweled chronometer having cut gears throughout.

Fluorescence in Oils

Practically everyone is familiar with the beautiful purple fluorescence which certain oils show. This phenomenon is much stronger under illumination by the inclosed arc than that of any other light, and is usually a property of mineral oils only. It has consequently been proposed that as a test for the purity of animal or vegetable oils, they be exposed to the light of an inclosed arc, when if pure, they do not fluoresce, while if adulterated with mineral oil, they will.

This test is usually conclusive; it is said that some of the lighter distillation products of petroleum can be bleached by prolonged exposure to sunlight until the fluorescence is no longer perceptible, while certain resin oils will fluoresce slightly under the inclosed arc. However, the test suggested will at least serve as a rough one for any who are suspicious of any alleged "pure" animal or vegetable oil.

Care of Governors

By C. R. McGahey

All governors require constant care if they are to perform their functions successfully. Improper oiling, dust, etc., will make them stick, and uneven tension of the springs, especially if they are rusted between the leaves, will cause

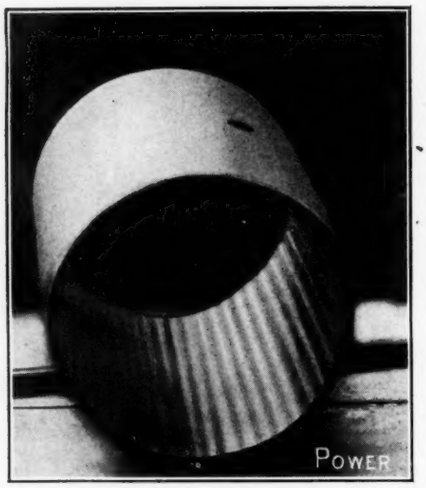


Fig. 1. Fluted Governor Bushing

very poor regulation and racing of the engine.

Fig. 1 shows a bushing taken from a standard shaft governor employing a roller bearing. The bushings, though made of hardened steel, were considerably worn and fluted, making poor regulation, as the governor arm hung in its movements and the roller could not operate freely.

In many shaft governors, the design of the main pivot is a troublesome factor to both designer and operator. Inadequate lubrication and dirt accumulation are other sources of trouble which can be eliminated if the bushings are grooved as in Fig. 2. The grooves should be made deep to allow a free movement for the grease or other lubricant.

Fig. 3 shows another case of wear common to governors of the single-bar type. The spring tension and weight wear the pivot at one side, thus causing the governor to jump, and produce poor regulation and much noise. The writer was called upon recently to correct this fault in a governor. After striking the springs a few blows with a hammer and setting them in line, as at *A*, *B*, *C*, Fig. 4, the engine showed excellent regulation.

When a governor is undergoing repair the springs should be taken apart and a liberal application of oil and graphite put between the leaves. The point *M* of the governor arm, Fig. 5, shows where trouble usually begins. Friction and irregularity of action will greatly increase as the wear at *M* becomes greater.

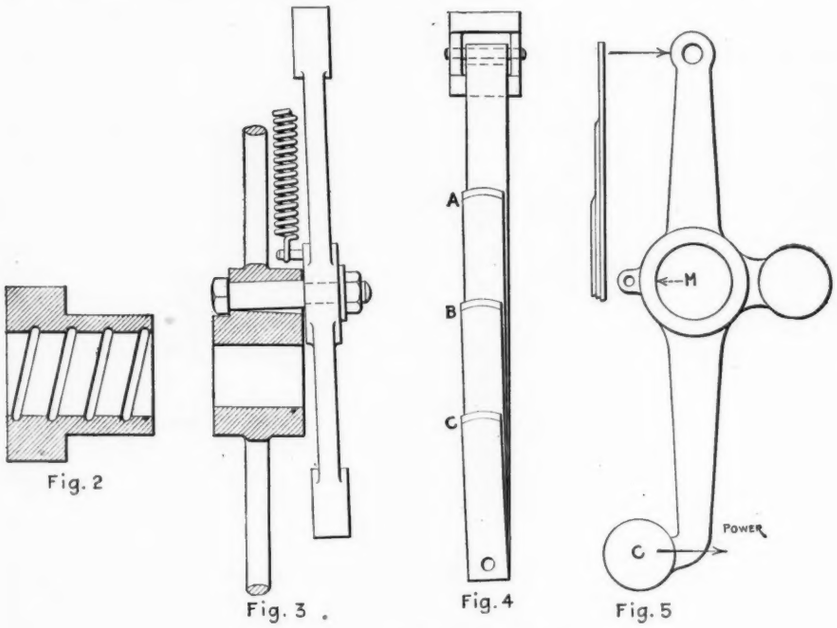


Fig. 2 Fig. 3 Fig. 4 Fig. 5

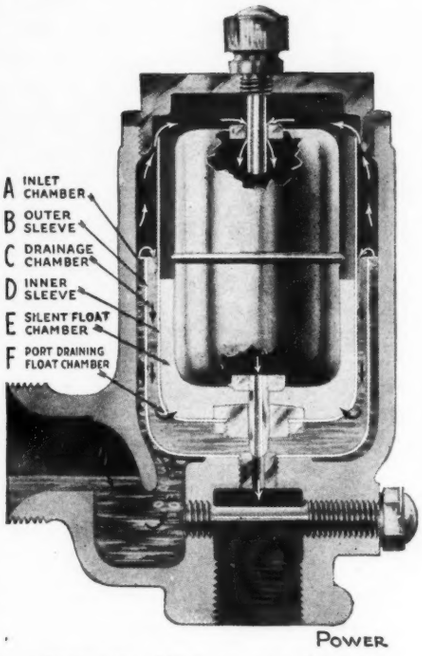
Showing the Governor Parts

Improved Monash Noiseless Radifier

In this device the water of condensation enters the inlet chamber over the outer sleeve into the drainage chamber, through the ports in the bottom of the inner sleeve, and enters the silent float chamber. A separate passage provides for the free and constant escape of air into the return through the center of the float.

When the water in the silent float chamber is at the line of flotation the float rises and the valve opens, emptying the drainage chamber. With the outrush of water the water level in the silent float chamber is gradually lowered by the escape of a little water through the ports, when the float sinks, closing the valve.

The float and drainage chamber are separate, each performing its individual function. Drainage from the drainage chamber into the return is direct and



Sectional View of the Monash Radifier Valve

rapid. The body of water in the silent float chamber is always still, with a slight and gradual lowering of the line of flotation, thereby insuring silent action of the float. The separate drainage chamber insures a direct discharge of oil, grease and dirt into the return pipe, instead of into the silent float chamber.

This device is for use on vacuum-heating systems. It is manufactured by the Monash-Younkers Co., 1407 West Jackson Boulevard, Chicago, Ill.

Kerr Economy Steam Turbine

A new type of steam turbine with vanes and blades producing parallel flow in the direction of the turbine shaft is being manufactured by the Kerr Turbine Co., Wellsville, N. Y. It is known as the Economy steam turbine and is built for condensing and noncondensing service in sizes of from 2 to 750 hp. capacity and in sizes up to 450 hp. for exhaust steam. A decrease of steam consumption of from 10 to 15 per cent. in noncondensing service and in some instances as great as 25 per cent. on condensing turbines is claimed by the manufacturers for this turbine over their former type.

The curves, Fig. 1, indicate performances under identical conditions of an

old machine rated at 250 b.hp. and an Economy turbine having the same number and diameter of wheels. With both turbines taking steam at 100 lb. at the throttle at rated load, the water rate under 26 in. vacuum was 24 lb., for the old as compared to 18.7 lb. for the new construction. Similarly, under 28 in. vacuum the water rate is cut from 23 lb. to 17.2 lb. The relative size of the two

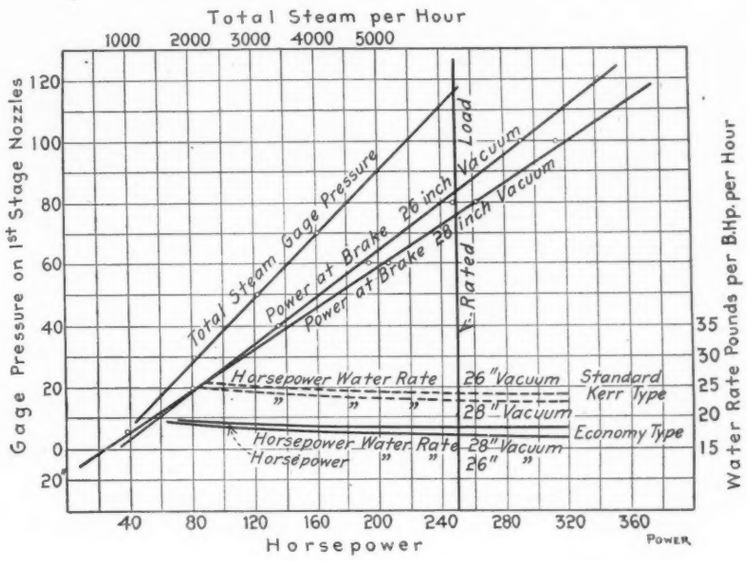

Total Steam per Hour
1000 2000 3000 4000 5000
Gage Pressure on 1st Stage Nozzles
120 100 80 60 40 20 0 20
Total Steam Gage Pressure
Power at Brake 26 inch Vacuum
Power at Brake 28 inch Vacuum
Rated Load
Horsepower Water Rate 26" Vacuum Standard Kerr Type
" " " 28" Vacuum
Horsepower Water Rate 28" Vacuum Economy Type
Horsepower " " 26" "
40 80 120 160 200 240 280 320 360
Horsepower
Water Rate Pounds per B.Hp. per Hour
35 30 25 20 15
POWER

FIG. 1. COMPARATIVE CURVES OF OLD TURBINE

types for equal duty is illustrated by the projections which are drawn to the same scale.

The departure from former design has been accompanied by an increase in strength of all the working parts. The jet velocity is kept low by expanding the steam in a succession of stages, usually from two to ten as may be desirable for different conditions of pressure and vacuum, and for desired steam-consumption rates at varying speeds.

Each set of nozzles discharges against a separate bucket wheel, steam entering the bucket at the side of the wheel and making the usual reversal. One set of nozzles and one wheel constitute a stage. Steam issues from the nozzle of the first stage, impinges upon the first-stage buckets and leaves within the first-stage casing a pressure to be expanded through the second-stage nozzles and imparted to the second-stage buckets and so on through the machine. Thus the total pressure drop is divided and the energy abstracted from the steam at each stage is comparatively small, the nozzles of the stages being so proportioned in number and size that the steam velocity is equal at each set.

The cylinder of the turbine is divided into separate stages by separate circular diaphragm castings between the steam- and exhaust-end castings. Each diaphragm casting contains one set of nozzles, provides for one bucket wheel and is arched at the center to withstand the steam pressure to the best advantage. These diaphragm castings are accurately centered with each other and with the two end castings by turned and bored tongue and grooved joints; the weight of the turbine is carried by feet on the end castings. The bearing cases also are centered by machined faces on the end castings and fall into alignment the same as the diaphragms.

Steam tightness at the joints and accuracy of alignment of the cylindrical parts of the shell are effected by annular machined tongues and grooves, the latter being packed with fibrous packing laid in graphite and oil. The sections of the turbine are bound together by continuous stay-bolts passing through drilled holes in the flange of one end casting and screwing into the flange of the other. Heat radiation is checked by filling in between the stay-bolts, and surrounding the cylinder and packing the turbine ends with lagging, held by an annular jacket and end plates of russia iron.

Leakage of steam about the shaft at the steam and exhaust end and between stages is prevented by floating bronze bushings in contact with ground metal seats and held to place on the shaft by the difference in steam pressures in the stages.

Fig. 2 shows, in addition to those bushings at the steam and exhaust ends of the turbine, packing glands for soft ring packing. Between the packing glands and the metal glands is a chamber which receives the leakage from the metal glands. A soft packing is used to confine the leakage within these chambers and prevent its escape along the shaft. The leakage through the metal gland on the steam end discharges through a pipe connection to one of the low-pressure stages of the turbine.

Leakage of air into the vacuum, where the turbine is run condensing, is prevented by supplying the chamber at the exhaust end with sealing steam.

The nozzles formed by walls within the diaphragms and thin metal vanes, which are die-pressed into shape and cast into the diaphragms, are adjacent to the bucket wheels with axial clearance between them and the buckets. The nozzles are of a form that has given maximum efficiency with the new type of bucket. The vanes are of a metal not subject to corrosion or erosion under service conditions.

The rotor, Fig. 3, is made up of bucket wheels, machined from flange steel of 60,000 lb. per square inch tensile strength, mounted upon the steel shaft. Each bucket wheel is bolted on a three-piece split steel or iron hub fitted to the shaft and kept from endwise or rotary movement by pin keys. A split mitered ring is forced by a locknut into the bore of the disk and against a turned taper, rendering the wheel on the hub quickly removable from the shaft when necessary. The buckets are drop-forged steel with a hard oxidized surface that are not subject to erosion or rust.

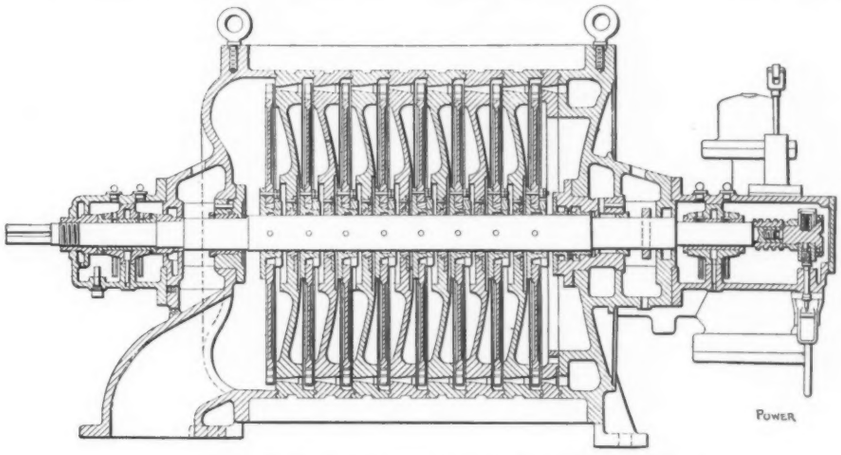


FIG. 2. SECTION THROUGH EIGHT-STAGE TURBINE

Steam is admitted to the turbine through

a steam chest having ports to the first-stage nozzles; a double-poppet valve is operated by the governor, the construction of which for average service consists

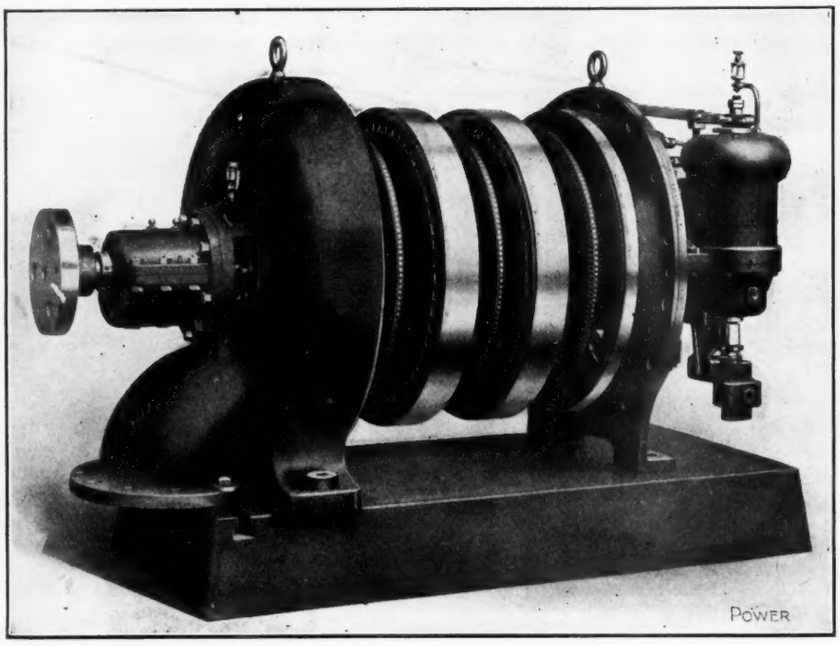


FIG. 3. INTERNAL VIEW OF THE ECONOMY TURBINE

of semiannular weights mounted directly upon the turbine shaft and acting through lever connections to throttle the steam valve. On the larger units, especially those for driving generators where close regulation is desired, the governor consists of spherical weights driven through a spiral gear on the turbine shaft and acting upon the valve stem through a relay pilot valve. An emergency governor is also employed to close a valve in the steam line when the turbine overspeeds, thus keeping the steam valve shut until reopened by hand.

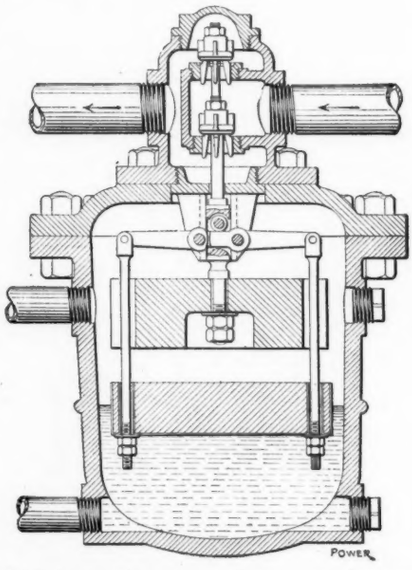
The main bearings are ring-oiling, self-aligning and split in halves for removal from the bearing case by removing the bearing-case cap.

On high-speed machines, oil is forced into the bearings at about 3 lb. pressure by a rotary pump on the end of the governor spindle from the reservoir that supplies the governor.

A thrust bearing and locating collar are provided in connection with the exhaust-end bearing, which insure correct position of the bucket wheels with reference to the nozzles.

Fogarty-Thoens Boiler Feed Water Regulator

The feed-water regulator illustrated consists of a vessel connected with the boiler above and below the water level and contains a balanced valve through which the feed water enters the boiler. The valve is opened or closed, more or less, according to the height of the water in the boiler, by a weight which is counterbalanced when half submerged, thus acting the same as a float. The regulator operates by gravity only, and eliminates all unreliable parts. It is positive in action and has no parts to stick, or get out of order.



SECTIONAL VIEW OF THE FOGARTY-THOENS BOILER FEED-WATER REGULATOR

This feed-water regulator is manufactured by James H. Fogarty, 126 Liberty St., New York City.

Correction—On page 193, upper part of first column, in the Aug. 6 issue, the delivery velocity of the air into the room should be 600 rather than 6000 ft. per min. The additional cipher was a typographical error.

Pump Valve Reseating Machine

The accompanying cut, Fig. 1, illustrates the improved Dexter pump-valve reseating machine attached to a pump ready for

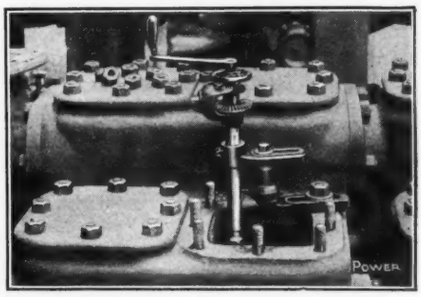


FIG. 1. MACHINE ATTACHED TO WATER END OF PUMP

reseating the lower valve seat. The seats in the upper valve plate are refaced in a similar manner. The machine is attached to the water end of the pump by

FIG. 2. MACHINE ASSEMBLED

bolting the yoke to any stud on the valve chamber. A few turns of the handle, while turning the hand feed wheel slow-

FIG. 3. PARTS OF THE MACHINE

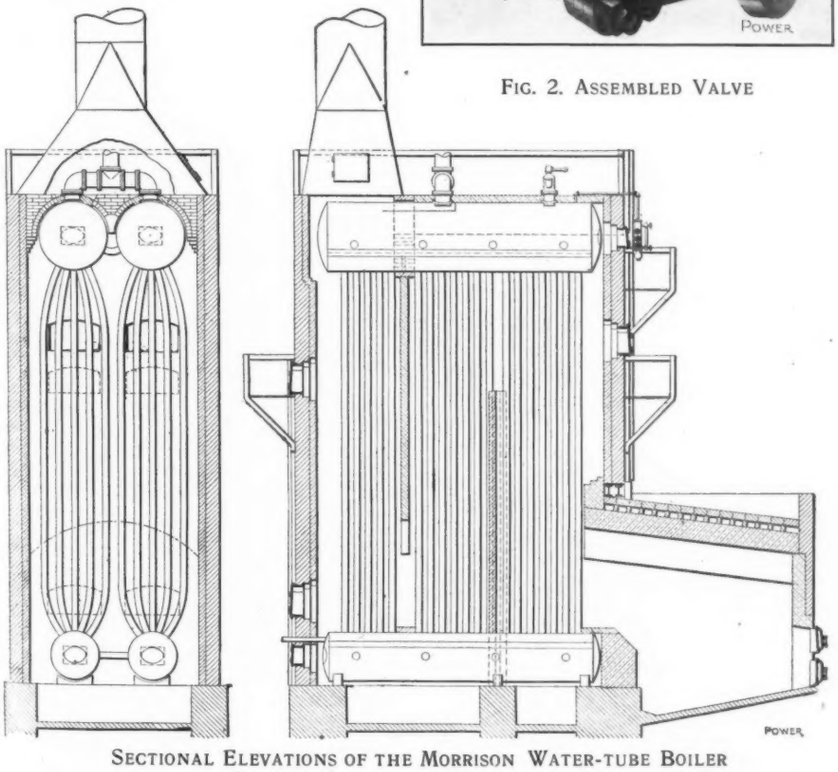
ly, refaces the valve seats without removing them from the pump.

Fig. 2 shows a machine for valve seats 2 to 4 in. in diameter. A view of the several parts is shown in Fig. 3. This device is manufactured by the Leavitt Machine Co., Orange, Mass.

Morrison Water Tube Boiler

This boiler is being manufactured in the United States by the Sharon Boiler Works, Sharon, Penn. It comprises two bottom and two top drums connected by tubes so separated that the entire arrangement is conducive to uniform and thorough combustion. Any tube in the boiler can be removed without injuring any other tube and also without displacing baffles or brickwork. This is accomplished by staggering the two intermediate rows of tubes in each bank with the center row, at the same time arranging the two outer rows in a series of short and wide spaces. The wide spaces in one outer row alternate with those in the opposite outer row. The boiler is built in single-, double- or triple-pass types and in single, double or multiple sections, end or side fired, depending on the location of the grate at the end or side of the drums.

The illustration shows an end and a side elevation of the boiler and dutch-oven furnace, and also the arrangement of the baffle walls. All surfaces are cylindrical in form and there are no bolted joints or gaskets to blow out. The longitudinal seams have butt joints with inside and outside straps. All parts are easy of access for cleaning out scale or soot.



SECTIONAL ELEVATIONS OF THE MORRISON WATER-TUBE BOILER

Forged Steel Valve

A new design of forged-steel valve, manufactured by the Patterson-Allen Engineering Co., 2 Rector St., New York City, is illustrated in section in Fig 1.

The body of the valve is made in three pieces from forged-steel boiler plate, bolted together, the center piece containing the valve seat. The valve stem yoke is fitted to the end section of the valve body, as shown in Fig. 2. The disk and seat are made from monel, the stem of nickel steel.

The forged-steel body is very strong and eliminates possibility of one side being thinner than the other. Each valve is tested to 1500 lb. per square inch hydrostatic pressure.

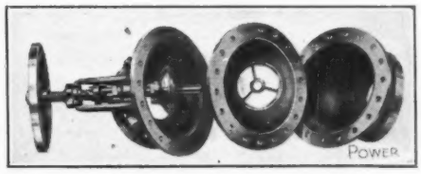


FIG. 1. SECTIONS OF VALVE

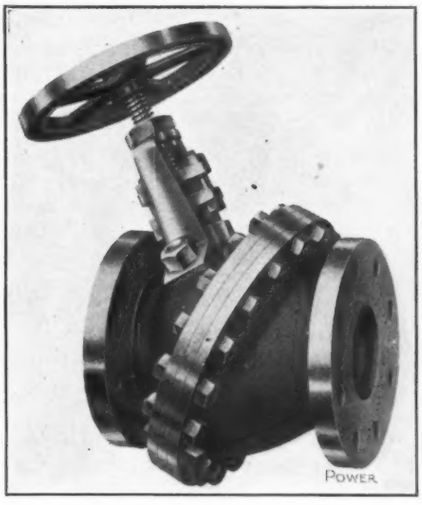
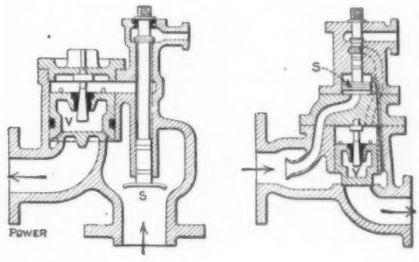


FIG. 2. ASSEMBLED VALVE

Differential Safety Valve

The accompanying engravings, reproduced from our German namesake, Kraft, illustrate safety valves in which the steam operates upon a piston or valve having differential areas. The lifting of this valve removes the boiler pressure from the top of the main valve, which is thus forced suddenly open to its full extent and so remains until the pressure is released sufficiently to allow the pilot or primary valve to seat. The seating of this valve shuts off the escape of steam from the back of the main valve, which, under the balanced pressure thus established, is seated by its own weight. In the engravings, the differential piston, or valve, is indicated by *s*, the main valve by *v*.



DIFFERENTIAL SAFETY VALVE

"Power Means Population"

When Augusta, Ga., needs an added facility in a business way, it immediately makes its desires known. And now it is more power. The Augusta *Chronicle* says:

"Augusta's crying need is more power, for power means population. For many years the water power of the canal has been exhausted. For many years there has been a demand for more power than the power company in the city could furnish.

"It is proposed to develop additional power above Augusta and bring it to the city. Ten thousand more horsepower is promised shortly; 24,000 hp. is declared available at this point.

"Here is what horsepower means. It takes 12 men to equal one horsepower; 10,000 more horsepower means the working energy of 12,000 men. If these men worked in eight-hour shifts, it would require the services of 36,000 men every 24 hours to produce the working energy of 10,000 more horsepower in Augusta."

NEW PUBLICATION

TWELVE PRINCIPLES OF EFFICIENCY. By Harrington Emerson. Published by "The Engineering Magazine," New York, 1912. Size, 5½x7 in.; 416 pp.; cloth. Price, $2.

This book is an enlargement of the author's previous work "Efficiency," and while it treats of the philosophy of efficiency, it is more specific on the fundamental principles upon which a practical efficiency system must be based. Read in conjunction with the former volume, it should prove of much assistance to those seeking a general conception of efficiency systems and also serve as a guide to efficiency engineers.

The first and second chapters are devoted to types of organizations which are wasteful because their progress is hampered by traditions and custom. As an excellent example of what may be accomplished by the execution of plans devised by a keen perception, the achievements of the German field marshal Von Moltke are cited.

Ideals, the first of the 12 efficiency principles, are considered in Chapter III, Mr. Emerson contending that the individual and aggregate excellence of an industrial organization depends upon its ideals.

Chapter IV is devoted chiefly to the lack of common sense exhibited by Americans in industrial and commercial operations, especially in the matter of imports and exports, and their mania for over-equipment. It is pointed out that the imports consist mainly of articles of luxury and delicate machinery, while the exports are of products which by their great volume tend to rapidly deplete the country's natural resources. This chapter is interesting and alive with valuable thought.

Competent counsel is the subject of Chapter V and deals with possibilities for increased economy by securing the services of a competent efficiency engineer, and Chapter VI treats of the admirable results obtainable in a business organization where a high order of discipline prevails.

Chapter VII, "The Fair Deal," contains among other subjects a common-sense treatment of the momentous question of wages, the number of hours in the working day and the highly injurious effects of overtime work.

Chapters VIII and IX, on records and dispatching, are also interesting. The remainder of the work is more specific in its treatment of the various efficiency principles.

A Small Engine Wreck

The Chambersburg Ice & Cold Storage Co., of Chambersburg, Penn., had an accident, Sunday, May 12, at 12:15 a.m. No one was killed or injured, but about $300 damage resulted.

The damaged piece of machinery was a Ridgeway high-speed slide-valve engine built by the Ridgeway Dynamo & Engine Co., of Ridgeway, Penn. It was rated at 28 hp. when running at 375 r.p.m., and directly connected to a Crocker-Wheeler 14-kw. direct-current generator and belted to a line shaft to which the following were attached: A George S. Comstock 4x4x4-in. power air compressor, a Goulds 2x4-in. triplex power pump for boiler-feed purposes, a Goulds 7x8-in. triplex power pump for condensing purposes and a countershaft to which two screw blade agitators were attached.

At the time of the accident this engine was running at 350 r.p.m. The accident was caused by the piston rod unscrewing from the crosshead and this broke the crosshead, crank bearing, crankshaft and buckled the connecting-rod, besides snapping the oiling pipes on one side of the oiling system and the gage on the reservoir and snapping the piston rod off at the piston head.

At the time of the accident only the tankman and engineer were on duty, who constituted the night crew and both were in the boiler room eating dinner. The Goulds 7x8-in. triplex pump stood not more than 2½ ft. from this engine and, although broken, parts were lying all around it, it was not even scratched.

When the engine was wrecked the lights went out. After procuring a torch, the men closed the throttle and exhaust valves and hooked the line shaft up on another small engine and ran all but the air compressor. The entire lighting system besides one of the elevators was supplied by the generator, but within 12 hr. after the accident purchased current was being used for the elevator and the lighting system switch was thrown on the "central service" one minute after the accident. No other damage than this was done and very fortunately no one was hurt for the engineer was at the engine only about five minutes before the accident happened putting oil in the reservoir.

The Bureau of Mines Recent Bulletins

The Bureau of Mines has copies of these publications for free distribution, one copy to one person. Order by number and title, addressing the Director of the Bureau of Mines, Washington, D. C.:

Bulletin 18. "The Transmission of Heat into Steam Boilers," by Henry Kreisinger and W. T. Ray, 1912, 180 pages.

Bulletin 40. "The Smokeless Combustion of Coal in Boiler Furnaces," with a chapter on central heating plants, by D. T. Randall and H. W. Weeks; 188 pages. A reprint of the United State Geological Survey Bulletin 373, revised by Henry Kreisinger.

Electric Power for Panama Canal

Electric power will be used almost exclusively in operating the Panama Canal. The hydro-electric station will be adjacent to the north wall of the Gatun spillway, and the installation will have a capacity of 6000 kw.

The average hydraulic head throughout the year will be about 75 ft. The maximum quantity of water diverted for hydro-electric development will be approximately 7 per cent. of the minimum water supply, and will be the excess which is not required for lockages, evaporation and leakage.

Locomotive Firemen's Capacity

At the recent Atlantic City convention of the American Railway Master Mechanics' Association, the firing capacity of a locomotive fireman was discussed. This capacity depends so much on the individual characteristics of the man and the peculiarities of the engine, the train and the road, that it is difficult to get any average figure, but it was brought out that the ordinary fireman working on a six- to eight-hour run generally does not fire more than 3000 lb. of coal per hour. It was also stated that on the passenger engines from 4500 to 5000 lb. of coal per hour might reasonably be expected.

An example of exceptionally high endurance and strength was noted by C. D. Young, of the Pennsylvania R.R., who stated that last summer in some capacity tests between Ft. Wayne and Valparaiso, Ind., a distance of 105 miles, a specially recommended fireman handled fuel for three hours at speeds greater than 60 miles per hour at an average of 8400 lb. of coal per hour.

This work was done with a No. 5 shovel. Mr. Young believes that had the man used a larger shovel he could have exceeded these figures. He also stated that in the locomotive test plant there were men who could fire as high as 9700 lb. of coal per hour.

St. Louis Steam Engineers Club

Organized less than two years ago, the St. Louis Steam Engineers Club now has an accredited membership of 300. Its homelike and comfortable quarters are at 810 Olive St., to which all visiting engineers and their friends are most cordially invited when in the city.

The board of directors meets every Monday evening, and on the first Wednesday evening of each month there is a general business meeting, followed by a concert provided by the entertainment committee.

During the winter months, one evening monthly is devoted to entertaining the ladies. An annual ball is given each winter and a picnic during the summer. Many delegates and visitors at the recent convention in St. Louis of the Universal Craftsmen, through the courtesy of E. N. Hunt, a well known member, were hospitably entertained at the club during their stay in St. Louis.

The officers are President Charles T. Parkinson, Secretary Price Simms, and the following board of directors: A. H. Herron, M. G. Skinner, H. C. Tulley, H. F. Rosenow, L. M. Sperry, O. P. Thompson, Price Simms, R. L. Brannon, F. C. Laufketter.

OBITUARY

F. J. Hunt, an engineer at the Milwaukee County poor farm at Wauwatosa, Wis., was electrocuted in the engine room of that institution on the night of Aug. 12. It is believed that he was fixing some wires when the accident occurred. Mr. Hunt was 36 years old and a member of Wisconsin No. 1 of the National Association of Stationary Engineers.

SOCIETY NOTES

For its joint meeting with the Verein deutscher Ingenieure, Leipzig, June 23 to 25, 1913, the American Society of Mechanical Engineers has appointed through its Council a committee consisting of Col. E. D. Meier, chairman, John W. Lieb, Jr., vice-chairman, Dr. W. F. M. Goss, Charles Whiting Baker, Major William H. Wiley and Dr. Alexander C. Humphries, president, and Calvin W. Rice, secretary, *ex-officio*. A very active interest has been manifested in the meeting and it is hoped that a sufficient number will signify their intention to attend to warrant the chartering of a special steamer. Besides Leipzig, where the joint meeting takes place, many other places in Germany have expressed their desire to give the American engineers an opportunity to see the advances made in the profession. Places it is tentatively proposed to visit are Hamburg, to visit the greatest shipyards in Germany; Munich, with a reception by the Prince of Bavaria; Berlin, visiting the industrial plants, and by special arrangement the castle of the Kaiser at Pottsdam; Essen, where there will be a reception by Krupp von Bohlen, Stuttgart, Düsseldorf, Cologne, Frankfort, Mannheim and Heidelberg. In Leipzig it is also expected that there will be, during the visit of the society, a patriotic gathering in commemoration of the Battle of Leipzig, and it is hoped that the party will be received by the Kaiser.

The second annual meeting of the Institute of Operating Engineers will be held on Friday and Saturday, Sept. 6 and 7, at the Engineering Societies Building, 29 West Thirty-ninth St., New York City. The committee on constitution and by-laws, which has been working for a year, will present its findings, and the changes and additions will be submitted for discussion.

The Sixth Congress of the International Association for Testing Materials will be held at the Engineering Societies Building, New York City, Sept. 2 to 7. About 170 foreign and about 55 American papers will be considered in the proceedings of the various sections. The entertainment program includes an informal reception, Monday evening, under the joint auspices of the American Society for Testing Materials and the American Institute of Electrical Engineers, the American Society of Mechanical Engineers and the American Institute of Mining Engineers; on Tuesday evening a reception by the city officials in the Public Library Building; on Wednesday afternoon and evening an excursion to West Point; on Thursday a reception by the American Society of Civil Engineers at its home on West Fifty-seventh St.; on Friday a harbor excursion, and on Saturday receptions by the Museum of Natural History and the Metropolitan Museum of Art.

The August meeting of the American Society of Engineer Draftsmen, held in the Engineering Societies Building on Aug. 15, was well attended.

W. T. Walters, a Chicago member, read a paper on "Safety Devices—Their Application and Design" which was followed by some graphic instances of the need of safety devices. Prof. Charles W. Weick, of Columbia University, gave an interesting lecture on "Practical Perspective" which aroused much interest and drew many subsequent questions. A question as to which is the better way to place figures on a drawing, perpendicular to the bottom of the drawing or perpendicular to the dimension line, created considerable discussion.

The American Museum of Safety, adjoining the meeting room, was thrown open for the evening to members and visitors to inspect the varied collection.

The sundry civil appropriation bill passed by the House of Representatives on June 21, and by the Senate July 24, contains an item appropriating $15,000 for the use of the Bureau of Standards in determining standard units of refrigeration, the physical constants of the materials used in the refrigerating industries and the thermal conductivity of materials. The securing of this appropriation is due to the efforts of the American Association of Refrigeration.

PERSONALS

Dr. William Cawthorne Unwin, F. R. S., president of the Institution of Civil Engineers of Great Britain, honorary member of the Institution of Mechanical Engineers of Great Britain and of the American Society of Mechanical Engineers, formerly professor of engineering of the Royal School of Naval Architecture and Marine Design and a well known authority upon hydraulic and machine design, will visit America in September as delegate of the Institution of Civil Engineers to the sixth congress of the International Association for Testing Materials.

Prof. John E. Sweet will attain his eightieth birthday this year, and it is planned to tender him a reception about the time of the annual meeting of the American Society of Mechanical Engineers of which he was one of the founders and is an honorary member and past president.

Herbert E. Stone is the New England agent for the Pittsburgh Piping & Equipment Co., contractors and engineers, with an office in the Equitable Building, Boston, Mass. Mr. Stone has for many years sold power accessories in New England, and was previously connected with the Chapman Valve Co. and the Elliott Manufacturing Co. He is a past national president of the National Association of Stationary Engineers, treasurer of the Commercial Engineers, and a member of the Engineers Blue Room Club.

Clemens Herschel, a consulting engineer, of New York City, has been appointed assistant to Lieut.-Col. W. C. Langfitt, Corps of Engineers, U. S. A., in connection with the hydro-electric development to be undertaken by the United States Government at Great Falls on the Potomac River above Washington, D. C.

E. P. Gould, for several years in the sales department of the Lunkenheimer Co., has acquired an interest in and will act as sales manager of the Steam Appliance Co., Milwaukee, Wis., manufacturers of steam and oil separators and steam traps. He resigned from the Lunkenheimer Co. on Aug. 1.

Frank H. Evans, for seven years New England manager for the Strong, Carlisle & Hammond Co., Cleveland, Ohio, has resigned and will take a much needed rest.

A business increase of 83 per cent. in the year in the revenues of the municipal electric plant at Riverside, Calif., is claimed by that city's government. This gain was principally made in increased industrial business.

A mail-tube line, 7½ ft. in diameter, is to be constructed in London by the British Post Office. Each vehicle will be operated by an individual electric motor.

Moments with the Ad. Editor

An old and valued correspondent of Power is Jas. E. Noble of London Junction, Ont., Canada.

Mr. Noble is an example of the kind of peaches the ad. editor started out to raise several years ago when this page was started.

This page was and is devoted to subscribers, not advertisers. Its whole purpose is to create for the selling section the interest that it deserves.

For, advertising generally is one of the most interesting, yes, even *romantic*, things in the world.

Forty years ago it was next to nothing. Now a billion a year goes into it in this country alone. Back of that startling progress are some of the best brains in the world, some of the most strenuous work and much of typical American energy and "get-there."

"Goods advertised in Power are made by reliable concerns," argued the ad-editor, "the subscriber who buys 'em is sure of buying satisfaction, advertising is now out of the 'bunk' class—and on a truthful basis—why not tell these things to those subscribers who, maybe, are still indifferent to the value of Power's Selling Section?"

Now read Mr. Noble's letter and you'll see an excellent instance of how it developed.

In the past I have told you about my experience with Power advertisers but a good thing will stand a second installment.

At one time I seldom read ads, but when Power started printing "Moments with the Ad Editor," I at first read the page from mere curiosity which rapidly developed into interest, not only in the page, but in the ads themselves. The third stage was the climax. I purchased some of the goods advertised and recommended the purchase of others with very satisfactory results to the buyers and probably also to the sellers.

I have recommended these goods to engineers (outside of my employer's plant) in numerous cases.

A short time ago I removed a number of pages from the Selling Section of Power, with ads of the makers of large power pumps, and sent them to a gentleman who was in want of just such information. I believe he sent to the advertisers in question for their literature and no doubt a sale will result in the near future.

I have used goods from most of the dealers mentioned in the July 30th letter and from several others who carry their ads in Power. In *every* case the goods were satisfactory and fully up to the standard claimed for them.

C. G. Scott of Wales, Wis., is another enthusiastic rooter for the advertising pages and if you doubt that just read his letter.

I read your page 'Moments with the Ad. Editor' the first time I looked the July 30th. issue through, and the next time I picked up Power I read it again.

I read the last paragraph several times before I realized that I had gone into a brown study and I found the main question in that study that I was trying to answer was, not what I have bought but what I have *not* bought through Power's ads.

Why, man, when I come to think, and your talk on page 174 set me to thinking, I find that I am using Power as a power plant appliance cyclopedia!

I've bought pump valves of Jenkins Bros., gaskets of McCord, lubricators from Greene Tweed, packing from Garlock, ventilators of Burt, steam pumps from The American and look which way I will in my plant I find something that I have either bought directly through advertisements in Power or through knowledge gained from advertisements read.

I read my Power from cover to cover (outside to outside) and I presume I spend as much if not more time over the advertising matter than I do over the reading matter. More than many times have arguments been settled through reference to advertisements in Power.

Let me say to conclude with Mr. Ad. Editor, if Power ever fires you, they might just as well fire me also for I will quit. As much as I think of Power, it would not be worth the money if they took away the advertising.

* * *

Any way you look at it, men, you'll always come back to the starting point, viz:

It pays to read advertisements and buy advertised goods.